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ABSTRACT

The emphasis of the eleventh meeting of the Panel on Science and Technology was on the management of information and knowledge. It was organized essentially as a seminar with two papers given at each session. The topic of the first two papers presented was: "Computers, Communications, and the Economy." The papers given at the second session were concerned with the kinds of ideals which have been guiding this society and the adequacy of these ideals. The next two papers covered education in a changing world. The problems of privacy and technological obsolescences were covered by another speaker. These papers are interspersed by introductory keynote speeches and discussion sessions. The appendix contains biographies of the panel participants. (NH)

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PANEL ON SCIENCE AND TECHNOLOGY

ELEVENTH MEETING

THE MANAGEMENT OF INFORMATION & KNOWLEDGE

PROCEEDINGS
BEFORE THE
COMMITTEE ON
SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
NINETY-FIRST CONGRESS
SECOND SESSION

JANUARY 27, 28, AND 29, 1970

[No. 15]

Printed for the use of the Committee on Science and Astronautics

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KEYNOTE SPEAKERS

Mr. McGeorge Bundy, president, Ford Foundation, New York
Hon. Earl Warren, former Chief Justice of the United States

MEMBERS OF THE PANEL ON SCIENCE AND TECHNOLOGY

Ivan L. Bennett, Jr., New York University (medicine)
Harrison S. Brown, California Institute of Technology (geology)
A. Hunter Dupree, Brown University (history)
Martin Goland, Southwest Research Institute (applied mechanics)
Walter J. Hesse, Ling-Temco-Vought (aircraft and missile systems)
Thomas F. Malone, Travelers Insurance Cos. (meteorology)
W. Albert Noyes, Jr., University of Texas (chemistry)
William F. Pounds, Massachusetts Institute of Technology (management)
Roger Revelle, Harvard University (geophysics)
Richard J. Russell, Louisiana Coastal Studies Institute (physical geography)
Athelstan Spilhaus, Franklin Institute of Science (oceanography)
H. Guyford Stever, Carnegie Institute of Technology (aeronautical engineering)
James A. Van Allen, State University of Iowa (physics)
Fred L. Whipple, Smithsonian Astrophysical Observatory (astronomy)
John T. Wilson, University of Chicago (psychology)
Maurice J. Zucrow, Purdue University (retired) (jet propulsion)

GUEST PANELISTS

Mr. Paul Armer, director, Computation Center, Stanford University, Stanford, Calif.

Prof. Stafford Beer, development director, International Publishing Corp., United Kingdom, and visiting Professor of Cybernetics in the Business School of Manchester University.

Dr. Daniel J. Boorstin, director, National Museum of History and Technology, Smithsonian Institution.

Ing. Fernando Garcia-Roel, rector, Instituto Technologico y de Estudios Superiores de Monterey, N.L., Mexico.

Dr. Thomas F. Green, director, Educational Policy Research Center, Syracuse University, N.Y.

Mr. Herman Kahn, director, Hudson Institute, Groton, N.Y.

Dr. George Kozmetsky, dean, College of Business Administration and Graduate School of Business, University of Texas.

Dr. L. Harvey Poe, Jr., firm of Howard & Poe, Washington, D.C.

Prof. Ioan D. Stancescu, Bucharest Technical University and counsellor, National Council of Scientific Research for Romania.

Dr. Osmo Antero Wiio, professor of organization theory and personnel management, School of Business Administration, Helsinki University, and consultant, SITRA Fund, Helsinki, Finland.

MODERATOR

Dr. Daniel Bell, professor of sociology, Harvard University, and Chairman, Commission of the Year 2000, Academy of Arts and Sciences.

PANEL ON SCIENCE AND TECHNOLOGY

OBJECTIVES

Develop background of technical and scientific information for the Committee on Science and Astronautics which is authoritative, timely, and candid, and which suggests the point of view of the scientific community.

Foster improved understanding on the part of scientists of the legislative responsibilities and processes as they relate to scientific research.

Identify spheres of scientific and technological research which offer exceptional promise for our national welfare and security, and which need further attention, strengthening, or shift in emphasis.

Discuss current methods for conducting research.

Provide information concerning availability of scientific manpower and educational needs.

Provide information on matters of international cooperation and organizations concerned with science and techonology.

Maintain channels of communication between the Congress and the scientific community.

PROGRAM

THEME: THE MANAGEMENT OF INFORMATION AND KNOWLEDGE

TUESDAY, JANUARY 27, 1970

10:00 A.M.

Call to Order:
  Hon. George P. Miller, Chairman
The Keynote:
  Mr. McGeorge Bundy, President, Ford Foundation, New York
Opening Remarks:
  Hon. John W. McCormack, Speaker, U.S. House of Representatives
  Hon. James G. Fulton, Ranking Minority Member
  Hon. Emilio Q. Daddario, Chairman, Subcommittee on Science, Research, and Development
Moderator: Dr. Daniel Bell, Professor of Sociology, Harvard University and Chairman, Commission of the Year 2000, Academy of Arts and Sciences
Discussion Period

2:00 P.M.

Computers, Communications and the Economy

Paper: Forces for Change in the 70's and 80's
  Summary Remarks: Mr. Herman Kahn, Director, Hudson Institute, Croton, New York
Discussion Period
Paper: Managing Modern Complexity
  Summary Remarks: Professor Stafford Beer, Development Director, International Publishing Corporation, and Visiting Professor of Cybernetics in the Business School of Manchester University, Great Britain
Discussion Period

WEDNESDAY, JANUARY 28, 1970

10:00 A.M.

The Individual, the State, and the Machine

Call to Order:
  Hon. George P. Miller, Chairman
The Keynote:
  Hon. Earl Warren, Former Chief Justice of the United States
Opening Remarks:
  Hon. Carl Albert, Majority Leader, U.S. House of Representatives
Paper: Self-Liquidating Ideals
  Summary Remarks: Dr. Daniel J. Boorstin, Director, National Museum of History and Technology, Smithsonian Institution
Discussion Period
Paper: The Individual: His Privacy, Self-Image and Obsolescence
  Summary Remarks: Mr. Paul Armer, Director, Computation Center, Stanford University, California
Discussion Period
Observations: Dr. Osmo A. Wiio, Professor of Organization Theory and Personnel Management, School of Business Administration, Helsinki University, Helsinki, Finland
Discussion Period

2:00 P.M.

Education for a Changing World

Paper: Education as Information Systems
  Summary Remarks: Dr. George Kozmetsky, Dean, College of Business Administration and Graduate School of Business, University of Texas
Discussion Period
Paper: Education in Post-Industrial America: Some Directions for Policy
  Summary Remarks: Dr. Thomas F. Green, Director, Educational Policy Research Center, Syracuse University, New York
Discussion Period
Observations: Ing. Fernando Garcia-Roel, Rector, Instituto Technologico y de Estudios Superiores de Monterey, N.L., Mexico

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THURSDAY, JANUARY 29, 1970

10:00 A.M.

Summary Views and Comments:
  Professor Ioan D. Stancescu, Bucharest Technical University, and Counsellor, National Council of Scientific Research, Bucharest, Romania
  Dr. L. Harvey Poe, Jr., Partner, Law Firm of Howard and Poe, Washington, D.C.
  Dr. Daniel Bell, Moderator
General Discussion
Closing Remarks:
  Hon. George P. Miller, Chairman

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ELEVENTH MEETING WITH THE PANEL ON SCIENCE AND TECHNOLOGY

TUESDAY, JANUARY 27, 1970

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 10:10 a.m., pursuant to notice, in room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller (chairman of the committee) presiding.

Chairman Miller. The committee will be in order.

Today, the Committee on Science and Astronautics opens its 11th annual meeting with the Panel on Science and Technology.

I wish to welcome all of you, the Panel, especially our distinguished guest panelists, both from this country and abroad, invited guests, and the public.

This is a particularly significant meeting since it marks the start of the second decade of scheduled annual seminars with the Panel. The Panel on Science and Technology has become an indispensable asset of our committee. From its inception as an experiment in cooperative effort between the legislative branch, the scientific, and the academic communities, to its present stature as a recognized instrument of advice and counsel for the committee and to the Congress, the Panel has provided timely information and advice to committee members, thereby providing a better insight into the myriad of scientific and technological problems facing the Congress each year.

I wish to thank the members of our Panel for their loyalty and devotion to this committee. The members have performed a most significant function in aiding the operation of the committee, both individually and on those occasions when we meet together in a group.

Since our last meeting, two new members have joined the Panel, both of whom are outstanding in their respective fields. I would like to welcome Dr. A. Hunter Dupree, who is presently the George H. Littlefield professor of American history at Brown University. Dr. Dupree brings to the Panel the historical scientific expertise necessary for our annual deliberations.

In addition, I would like to welcome Dr. William F. Pounds, who is presently dean of the Sloan School of Management, Massachusetts Institute of Technology.

Dr. Pounds' extensive experience in the management field, both in the industrial and academic communities, will fill a much needed void in the disciplines represented by the Panel.

Today, we are meeting to discuss the matter which I believe is of singular importance to our present society and the future of mankind. During the course of the next two and a half days, we propose to discuss the impact of the computer, cybernation, and communications on modern day and future societies, to identify problem areas where legislative emphasis may be of benefit, and to explore the economic, individual, educational, and international implications associated therewith.

I am sure all of you recognize there may be complex facets to the subject, which is why we have asked a number of distinguished scientists and educators from other countries, as well as the United States, to put forth their views on this subject.

I would like now to introduce our guest participants to this most important meeting, and ask they stand briefly as I call their names.

Mr. Paul Armer, who is director of the Computation Center at Stanford University.

Prof. Stafford Beer, who is a visiting professor of cybernetics at the Business School of Manchester University in Great Britain, and also the development director of the International Publishing Corporation in London.

Dr. Daniel Bell, professor of sociology at Harvard University, will serve as moderator for the entire session.

Dr. Fernando Garcia-Roel, an outstanding engineer, and director of the Institute of Technology and Advanced Studies in Monterey, Mexico.

Dr. Thomas F. Green, who is director of Educational Policy Research Center at Syracuse University.

Mr. Herman Kahn, director of the Hudson Institute in New York.

Dr. George Kozmetsky, dean of the College of Business Administration and Graduate School of Business at the University of Texas.

Dr. L. Harvey Poe, Jr., partner in the law firm of Howard & Poe, Washington, D.C.

Prof. Ioan D. Stancescu, who is with the Technical University at Bucharest, and counselor for the National Council of Scientific Research, Bucharest, Romania.

Dr. Osmo Antero Wiio, who is professor of organization theory and personnel management at the School of Business Administration at the University of Helsinki, Finland.

Now, it gives me great pleasure to present to you the keynote speaker of the session today, Mr. McGeorge Bundy, the president of the Ford Foundation, who needs little introduction to this audience.

He has had extensive experience both in Government and academic communities. Prior to his assuming his present post, he was appointed by President John F. Kennedy to the position of Special Assistant to the President for National Security Affairs. In this capacity, he served as staff officer on foreign and defense policy for Presidents Kennedy and Johnson.

We are highly appreciative of his generosity and graciousness in coming here and talking to us this morning. It is a great privilege and honor to welcome Mr. McGeorge Bundy.

If you will pardon me, all of us make mistakes. I forgot to introduce Dr. Daniel J. Boorstin, Director of the National Museum of History and Technology of the Smithsonian Institution.

KEYNOTE ADDRESS BY McGEORGE BUNDY, PRESIDENT, FORD FOUNDATION, NEW YORK

Mr. Bundy. Mr. Chairman, Mr. Speaker, members of the Panel, guest panelists, distinguished guests.

It is a great and undeserved pleasure for me to have a chance to talk with you this morning about some elements of the enormous topic which has been chosen for your discussions this year.

This process by which the Committee on Science and Astronautics has undertaken to engage itself with men of special understanding and concern, who have been members of the Advisory Panel over these years, is an unusual one in the American governmental process, and I believe, on the basis of the informal but considerable contact which I have had over the years with these kinds of problems—and the range of what comes before this committee is astounding—that this process is one example among many of the way in which this particular committee has kept abreast of and often ahead of the extraordinary range of critical issues which have passed beneath its review.

It is a risky business for a variety of reasons to call a foundation executive before any House committee.

[Laughter.]

Mr. Bundy. In the current season, it is a display of courage on the part of your chairman, and is deeply appreciated; indeed there is more courage than meets the eye in it, because although the motivation was surely pure, a group concerned daily with the relation of scientific knowledge to public policy runs a considerable risk in inviting a generalist to keynote any part of its deliberations.

You run the risk, maybe, of the visitor turning his mind for the first time, and rather superficially, to issues which you have lived with hard and long.

You run the risk the visitor may have only partial or obsolescent perceptions of the subject whose shape is changing very fast.

You run the risk he may pursue a line of inquiry or a hobbyhorse tangential to your own main purposes; and these risks are accentuated when you deal with a visitor whose experience in relationship to knowledge during the decade of the computer explosion has primarily been in the executive branch of the Federal Government and in private philanthropy.

These are two different worlds—quite distinct—but they share one characteristic which this morning's assignment has focused for me. They both have a short memory and a far greater preoccupation with the opportunities of tomorrow than with the evaluated inadequacies of yesterday.

As a result, private philanthropy and the executive branch of the Government have a strong tendency to base their actions for today and their plans for tomorrow at least as much on the apparent lessons of personal testimony and immediate and quite human pressure rather than systematic mobilization of impersonal, historical, and tangible evidence.

To state this reality, the way in which decisions are made, is neither to condemn it nor to excuse it, but to register it as a limitation on the feeling of someone who has lived this way for the issues which you have gathered to explore.

They are uncommonly hard ones, and they will need a much more rigorous treatment than you can get from any one introductory set of comments.

As I read it, the subject of your meeting in its declarative form is "The Management of Information and Knowledge." It implies a problem, a capability and a potential, if unrealized, benefit.

The problem is that in most, if not all spheres of inquiry and choice, the quantities of raw information which are needed and are increasingly available overwhelm in magnitude the few comprehensive and trusted bodies or systems of knowledge that have been perceived and elaborated by man. I am thinking, here, not only of knowledge systems with predictive value, but also of information systematically organized to yield the benefit of comprehensive description.

Where, for example, does the novice urban mayor turn today to get a comprehension of the interrelationships between transportation, employment, technology, pollution, private investment, and the public budget? Where does the concerned citizen or Congressman who is interested in educational change go for the best available understanding of the relationship between communications, including new technology and learning? Who can the modern woman consult when she seeks comprehensive and reliable information on the psychological and biological implications of using "the pill"?

Yet, if streams of unassimilated, and certainly unmanaged, information inundate us in the midst of this kind of thirst for understanding, computer information systems, taken comprehensively, do seem to offer an unprecedented capability of addressing this age-old problem. They promise this first, because of their vast capacity to store and recall data; and, second, because of their usefulness as a speedy tool in sorting out orders of relationship and dependency among many separately observed phenomena.

And the faith of modern man reasons that we all can reap important social benefits if we harness the capabilities of modern systems of information analysis and storage to convert data into knowledge, and then apply the product as widely as possible to issues of social and personal choice.

Now, if I have correctly stated these elements of need, of capability, and of potential benefit, then I would register much more than less as a believer. At the same time, my own interest and allegiance is engaged much more by the potential for good of modern technology than by the present state of the art of application.

The results from employment of computer analysis in the service of policy choice in military affairs and in private enterprise have clearly been erratic, and ought to induce caution in other potential users. Even in these areas, where systems have relatively clear boundaries, and objectives at least appear to lend themselves to precise specification, experience with application underscores the limitations of technology alone.

It is susceptible only to data which can be quantified and distortions in judgment will occur when nonquantifiable aspects are badly misjudged or omitted entirely from the calculus.

There is a problem of the direct relationship between the quality of raw data elements or inputs and the value of the knowledge output.

There is a necessity that one's theory or explanatory hypothesis bear at least a partial approximation to reality.

Indeed, in the light of the findings of some recent congressional investigations, one cannot help wondering whether it remains possible for even the most systematic and most rigorous process of analysis to comprehend and master the complexities and uncertainties of modern weapons systems which, as I say, would seem at first blush to be a relatively simple and well-defined world of analysis.

With these limitations in mind, I do nevertheless want to suggest, this morning, that the endangered environment offers a current, a large and an urgent opportunity for the exercise of the kind of faith in the reasoning process which I have just described. If the popular press is any guide, the necessity of preserving and restoring the environment seems finally to have approached the top of our agenda.

Fortunately, some sectors of our body politic were ahead of the current and nearly universal alarm. With important leadership from Congressman Daddario and his Subcommittee on Science, Research, and Development, Congressmen Saylor and Dingell, and in the upper Chamber, from Senators Muskie and Jackson, the Congress has led the way in suggesting the intellectual, managerial, and economical resources that America can and should offer in this worldwide awakening.

While it seems indisputable, as President Nixon insisted last week, that prompt action is required now to restrain the processes that pollute, and sizable commitments are necessary to clean up the messy legacy of earlier indifference, we also have an overwhelming need to learn more clearly how the acts of man affect the stability and instability of nature's systems.

As the Stanford study group on environmental problems of the National Academy of Sciences has noted in its recent appraisal of the crisis, we cannot effectively manage the environment without knowing what it is, what it was, and what it can be.

At present, we do not comprehensively or regularly measure environmental quality. We do not know how and to what extent it is changing and has already changed. Much of the information now gathered under the aegis of environmentally oriented agencies—and there are many—such as The Geological Survey, the Bureau of Commercial Fisheries, the National Air Pollution Control Administration and the Federal Water Pollution Control Administration—much of this information, probably most of it, is obtained for special purposes. Not surprisingly, but most unfortunately, no agency is either assigned or assumes responsibility for conducting an overall ecological evaluation of the quality of the environment as a whole, nor is there any common interchangeable or comparable sampling method now in use, though the quality of the air, for example, quite clearly impinges on the quality of water.

But, if a first requirement is to conceive and install a systematic and comprehensive system of ecological observation and data collection, there is also a large need for analysis, for manipulation of information, probably on a grand scale, to identify the simple correlations between independently observed and measured phenomena, and for testing of intellectually ambitious models of ecological reality to improve our powers of prediction and spur our defensive, preventive actions.

If in short, it now seems urgent, and perhaps even critical, to take the largest view of our environment and of its interrelating subsystems, and to address issues of strategic management and preservation, then it is surely fortunate that information technology begins to make it possible to do so.

Indeed, some scholars, often with Foundation support, are now coming at environmental analysis from two sides: The economic and the ecological. Both approaches strive to understand the complex interrelationships of mankind with natural systems and the causes of equilibrium or of instability.

Each approach explores and seeks to identify relationships of dependency between independently observed phenomena. When we consider a stream, for example, analysts attempt to define the relationship between the discharge of specific amounts of organic materials at specific locations, and the need of the stream for oxygen at the same locations. Out of a series of such equations, it seems possible to develop mathematical models which, at their best, may represent primitive skeletons, at least, of a complex system.

Formalized, quantitative relationships lend themselves to mathematical manipulation as verbal descriptions of reality cannot. With the goal, for example, of achieving a given standard of water purity in our stream, a good model should enable us to discern the range in cost of several alternative "cleanup" strategies combining elements of plant relocation and modified production methods.

Ecologists and economists have already demonstrated that model building and analysis can yield more penetrating insights than might come exclusively from the logic of lay observation or commonsense, and can also have practical application.

To take a rather specialized example, the mathematical models of whale populations have predicted within a two percent error what the annual catch would be. These models could have been used to fix quotas at a level to protect whale populations and enable them to recover from the tragic overfishing of the past decades.

That quotas have not resulted, is a political, not a scientific, outcome. Better, though still inadequate, use has been made of models of the Pacific salmon industry, which show the most effective kinds of restrictions on fishing and which identify the occasions when their application will offer the most protection to the salmon.

Economists at Resources for the Future have recently challenged a plan by the Army Corps of Engineers to build a number of dams on the upper Potomac and its tributaries. The Corps proposed, in part, to construct these dams to hold water that could subsequently be released in dry season to dilute wastes in the lower river and thereby sustain throughout the year a steady standard of water quality.

The analysts in RFF constructed a mathematical model of the hydrology of the river basin and explored the costs of a number of alternative methods of assuring the given standard, as well as higher and lower standards, of water purity. They found that all alternatives, combining various treatment methods were substantially cheaper than the proposed dams, and that some cost only one-tenth as much.

Here we have an illustration of the generic difficulty of analysis and recommendation when those making the analysis and the recommendation may have a special interest or concern in a particular way of solving the problem.

Now, to be sure, all these models have or could have practical immediate utility in saving whales, saving money, or insuring water quality. What is more important, for our purpose is that they offer promising evidence that analysis of complexity can enhance the rationality of decisionmaking. Even if one knows that a reservoir is a more expensive way of keeping the Potomac clean than advanced waste treatment, one may still prefer to keep it clean in this more expensive fashion.

Similarly, it is quite conceivable that a decision to exterminate whales might be deliberately arrived at. It is deliberation that the models make possible, and, indeed, in some sense, enforce, and that is not the least of their social value.

For our part, in the Ford Foundation, we seek to contribute our share to the creation of expanded, relevant kinds of information about our environment and the threats to it that this time requires. Five years ago, the foundation's board of trustees, on the recommendation of my predecessor, authorized the development of a program in resources and environment, and our experience in this increasing effort in recent years suggests to us the very high priority that should now be attached to study and appraisal of the environment on the broadest scale.

We have recently begun intensive discussions with scholars and public officials on this question. And while we have no formal recommendations, at least as of this date, as to the ways and means of proceeding, we are encouraged to believe that there is a vital and complementary role that philanthropic institutions can play along with the executive and legislative branches of Government, other educational and research institutions, and indeed the family of nations acting in concert to facilitate the broadened intellectual attack these problems require.

The environmental dangers we face, the systems we need to understand, and the remedies to be fashioned, will frequently be international in character, an aspect properly recognized by the recent, relatively underreported decision of the Secretary of State, Mr. Rogers, to create an Office of Environmental Affairs, headed by Mr. Christian Herter, Jr., in his office.

I myself am convinved that energy for both rigorous study and prompt action must derive from national governments, and not be remanded to, or anticipated from, supranational agencies or voluntary assemblies of motivated individuals sharing the same concerns or intellectual training across political boundaries. There is no substitute for the motor force that comes from governmental power. At the same time, I also see important possibilities for international cooperation and collaboration in these urgent tasks.

There is not only the manifest fact of our national interdependencies in relation to the environment across national boundaries; there is also no obvious, ideological basis for disagreement over causes or relative responsibility and no political gain to be realized from a posture of isolation.

Indeed, there is some reason to believe that even potential adversaries, at least in other fields, will welcome and be responsive to an initiative for communication and intellectual consultation on these complex scientific and technological questions. And there is certainly reason to hope that a fruitful intellectual consideration of our common stake in preserving the environment could facilitate discussion of even harder issues of common concern.

In addition to the political possibility for cooperation there is the undeniable fact that the human race, as a whole, confronts problems of awesome complexity. The intellectual talent which must be encouraged to address these problems is not only exceedingly scarce, but also geographically and politically dispersed. Every experience that I, at least, have had in exploring issues of common concern with the intellectual and scientific leaders of other societies and states, has confirmed what I think one can feel in one's bones to be true, that the best ideas and perceptions are likely to emerge from circles of intellectual competence deliberately made as inclusive as possible.

So, as we launch this decade—and it will probably be much longer than that—of attention to the environment, there is much to be said for activation and steady cultivation wherever possible of a workable process of international intellectual consultation and collaboration with nationals of countries that may be potential adversaries as well as with traditional friends. This process will not happen automatically. It needs to be made someone's business; it necessarily requires a new order of collaboration between the State Department, the science agencies, and the nongovernmental academy; and it should have congressional encouragement, as it clearly has from this committee and from this Advisory Panel, as well as executive direction.

One can conceive of at least three different levels of fruitful international exchange:

First, we should make every effort to insure that the national systems for monitoring, collecting, and storing environmental data are compatible. I believe that early and serious effort across political boundaries, to achieve intellectual consensus concerning the key phenomena to be observed, and the quality indices to be established, can obviate dangers of poor or nonexistent linkages between mechanical national arrangements for collection, storage, retrieval, and exchange.

Second, assuming, as I do, that each nation will independently pursue research and experimentation in remedial actions, information on work in progress, on results and understandings, however tentative, must flow freely across political boundaries. There is simply too little time, brainpower, and public money available for nations to operate in this area either in a chauvinistic or unconsciously introverted fashion; for countries to run up blind alleys, trod earlier by others, or remain ignorant of promising approaches under scrutiny elsewhere.

The responsibility for insuring the necessary exchange of information in these matters rests with each nation and its interested intellectual community, and the priority for public policy here, it seems to me, is the provision of resources for an expanded flow of personnel and information materials from points of national origin, rather than the creation of new, allegedly coordinative international agencies.

Third, when the necessary intellectual mobilization begins to yield operational applications, there will surely be opportunity for shared international effort. The developed countries will have their traditional obligations vis-a-vis the emerging countries, and new patterns of international law and management seem likely to be required with respect to our priceless, collective oceanic, and inner and outer space assets.

Now, the prospects for a successful defense of our natural environment, within our own political sphere, as well as in cooperation with others, cannot be insured simply by a commitment to a deeper and broader intellectual inquiry, however fundamental I believe that is. It will also depend on at least two other factors which have historically been a concern of this annual gathering, and which remain worthy of your attention in these days.

I refer, first, to the health of our system of higher education, and in particular, to our system at the graduate level for the development of an adequate supply of professionals, skilled in many fields and motivated to tackle these vast, but imperative problems of public choice and policy; and, second, to the health of our political process, its responsiveness to the requirements of national welfare, its capacity for sober deliberation, wise choice and timely, effective action.

I, for one, share the anxiety that many feel today for adequacy and well-being of each of these vital systems.

In higher education, the problems are many and complex. There is, to begin with, the anxiety that many intellectuals and scholars feel at the seeming incapacity of our society to put first things first; the anguish they feel over their perception of a civilization which seems awash in its own errors and excesses.

It would be a grave mistake to blink at the increasing estrangement that many of the most gifted in the American Academy, and not just the young, feel toward the values that swirl and prevail in the larger culture and society that encompasses them and their work and their inclination to withdraw from engagement with problems upon that larger scene.

At the same time, complementing this external criticism, there is a self-examination and search among many scholars for a fresh and vital definition of the tasks and role of academic men in modern life, an inquiry undoubtedly induced in part by the relentless probes of questioning students motivated to make a difference, an inquiry not unrelated to the apparent obsolescence of many of the structural forms that have grown up in the contemporary university.

Yet, if these enigmatic forces are easier to describe than to reconcile, my quick earlier survey of some of the dimensions of the intellectual challenges of environmental restoration may have suggested my own personal conviction that no modern society is going to make it if it fails to connect its muscular actions, its actual operations in society, to a discriminating intellectual process.

The demand for guidance and understanding by the intellect has never been greater and not only with respect to the environment, but it is also true in the voracious demands of modern society for increased scholarly attention and more powerful intellectual insight concerning the learning process, the aging process, the reproductive process, urbanization, and all of the forces which compel both human adaptation and institutional change in the technological era.

My own feeling is that the ongoing and many-faceted debate over academic purposes and values will find a continuing focus in the intersection of the important questions of intellectual freedom with the forms of educational finance, which is an emerging problem on the horizon of everyone's consciousness, if not yet clearly at the top of anyone's formal agenda (except perhaps for the college presidents and boards of trustees who see it face to face in this season).

We have finally faced up to at least some of the distortions and dangers of channeling disproportionate amounts of Federal aid for graduate training, research, and for institutional development through the defense budget. We seem increasingly aware, as well, that grants of fragmented financial support for highly specialized, if appropriate educational objectives do not invariably produce a coherent or healthy community of scholars and students at the point of actual operation in the college or university.

But the broader national debate—in part, clearly, a political debate which must be led by responsible governmental leaders—which will define and affirm the goals of our system of higher education both for individuals and for society and the terms of public support and accountability, has barely begun and is increasingly urgent.

In this necessary discussion, the Congress and the public have a right, in turn, to expect the academic community to come forward with the professional, the curricular, the organizational innovations, and protections which an era of protracted engagement with issues of welfare and policy will require.

There is no substitute, in other words, in this, a critical period, for a new level of interaction between the leaders of the educational community and the leaders of the political community.

Now, finally, and returning really to this problem of the environment and of the relation between what we understand of it and what we do about it, I come to the interaction of ideas and action—the capacity of a general and informed public no less than of the leadership of a democracy to make wise and effective commitments in policy and in program when tested and reliable information is available.

I have argued earlier that the computer can help us to achieve a more penetrating and encompassing understanding of the world's natural systems and how man affects them. In the hands of men of powerful and scrupulous intellect, this modern tool can help us to define the situation, but I have not asserted, and I do not believe that this intellectual process will define "an" answer or "the" remedies.

For action, we must look to the political process. That is the arena where facts are assayed and values collide, where interests compete and policy or stalemate results. And when the needed observation and wider analysis of our threatened environment is further along, my own guess is that the necessary remedies and the assessment of damage costs will cut profoundly across many of our deeper values, especially in the economic ethic and motor of our national life.

This new knowledge of where we are, and perhaps of how late it is, may place great strain on our political process. There will be no obvious, consensual and painless technical panacea available to us. We will not be able to avoid a widened definition of the processes of industrial production which will embrace the full costs of safely disposing of or of recycling waste materials. There will be sharp political conflict over the assignment of these additional burdens of cost. There will be clearer understanding of the price to the current generation of environmental damage unconscionably shunned by earlier eras, and we may have indisputable evidence that further procrastination will lead to irreversible destruction.

In his recent state of the Union message, President Nixon has suggested the possibility of a conscious and active national policy of redistribution of population, and he has also challenged the assumed identity between economic growth and individual well-being. He has thus identified two of the central topics of a far-reaching debate on the future quality of our life.

The values of our society and the quality of our politics will surely be tested sharply by choices between adequate and insufficient action; by the assignment of the burden between producer and consumer, between private and public sectors, and between present and future generations.

In that great debate, we will be enormously dependent on the ability of men of scholarship and knowledge to communicate dangers, and the range of promising strategies and operational urgencies in terms that are understandable to the general public and to those with political responsibility for action.

We shall also need a political process which is both open and coherent. On the legislative side, that process must afford opportunity for representation of views by individuals with a human interest as well as by organized groups with a more tangible economic interest; representation of views in behalf of the unvoiced, but nevertheless real stake of future generations as well as that of participants in the next general election.

And in the execution of the generally approved programmatic course, if we should reach that stage, legislation should be strong enough to prevent bureaucratic splitting of the difference of underlying disagreement by tolerating or encouraging executive agencies to operate independently and inconsistently, one with another, undoing with today's directive or action on this side of town what was painfully resolved in someone else's office yesterday.

In the end, the effective translation of the desire of man to preserve his environment and the achievement of that preservation, will depend upon the skills of the public man—the capacity of the individual legislator and of the executive decisionmaker to sift the evidence, to discriminate between theories, to interrogate the scientists and scholars, to reach conclusions and to help create the public understanding and support for necessary action.

In the era of information explosion, societies can become paralyzed by a plethora of facts and the absence of obvious conclusions. Or, they may freeze when the indisputable facts and necessities offend received values and conventional wisdom.

Neither form of paralysis is likely, certainly not necessary, if the linkages between the arena where policy is forged and the relevant circle of informed and disinterested citizens and scholars are firm and easy. This audience and its gatherings in earlier years, happily embody that process, that value, that tradition at its best. The agenda of your common concern is important evidence for the proposition that the discoveries of science and the disciplined intellect must be made to serve, must tend to serve, rather than overwhelm mankind as he sets out in a new decade to tackle his unfinished agenda of pollution, pestilence, population, poverty, and personal productivity. [Applause.]

Chairman MILLER. I think the reception of your remarks, Mr. Bundy, indicate their importance to these people. I want to thank you for them.

It now becomes my very great honor to introduce a man whom I have had the privilege of knowing for at least 25 years and whom I look upon as a great American statesman.

The Honorable John W. McCormack was the father of this committee. Some 12 years ago, he anticipated the necessity, in Congress, for a voice that could keep abreast of the then rapidly developing times. He chaired an ad hoc committee that resulted in the adoption of the Space Act and in the establishment of the Committee of Science and Astronautics within the Congress.

I want to thank him for his continuing support and encouragement. He has never missed one of these meetings. We have always been able to go to him. He has been most generous with his time and efforts in our behalf.

It is my privilege to introduce the Speaker of the House of Representatives, the Honorable John W. McCormack. [Applause and standing ovation.]

REMARKS OF HON. JOHN W. McCORMACK, SPEAKER, HOUSE OF REPRESENTATIVES

Speaker McCORMACK. Mr. Chairman, distinguished members of the Committee on Science and Astronautics, guest panelists, Dr. Bell, the moderator, and ladies and gentlemen:

We have just listened to the keynote remarks of Mr. Bundy. I want to congratulate him. They are very profound indeed, and I might also say constituting a challenge that confronts all of us without regard to what our sphere of activity might be.

It is a pleasure for me to join with you at this 11th meeting of the Panel on Science and Technology. This annual event has been distinguished over the years by the high caliber of the participants, the important subjects which they have discussed, and the opportunities that it has afforded legislators and scientists to meet in friendly exchange of views.

As one who has come each time over these many years, I have always looked forward with anticipation to the array of topics and the new participants, many from other parts of the world, and I have welcomed the opportunity to talk again with old friends who serve on the permanent panel.

Let me assure you that I view the Science and Astronautics Committee as yielding to no other committee of the Congress in the important role it can play in shaping the destiny of our great land and in having its effects throughout the world.

I was chairman of the predecessor select committee which wrote the Space Act, and out of which this permanent committee grew, as Chairman Miller so kindly mentioned in his introduction of me. I deliberately moved to amend the rules of the House to extend the jurisdiction of this committee over all of science. The space program, important as it is, was only a harbinger of the proliferating public issues associated with science to which the Congress must bring close attention.

Many of us in the Congress, who are not ourselves scientists, are made uneasy by the dangers of misuse of science; but, at the same time, I also have faith that in working together to weld the humanistic interest of Congress with the technical objective interest of the scientists we can make science our tool and not our master.

As I look at your intended program this year, with its emphasis on the management of information and knowledge, I am aware of the importance of these same problems within the Congress. The Speaker, the majority leader, the minority leader, and the whip face problems of information management. The Rules Committee and other committees represent management tools working in behalf of the larger objectives of the House.

There are corresponding needs and functions in the other body, and you notice I mentioned the other body.

Congress itself suggests, at the opening stage, considering how the modern tools of science can be employed directly in managing its own information flow. This must be done in ways that we feel enhance our certainty of knowledge and decisiveness, not in ways which force Members unfamiliar with computer programing to remold themselves or to surrender any of the powers granted them under the Constitution to a hired staff.

Our problem with the information explosion in the Congress is but a reflection of the growing complexity of the larger world. We cannot ignore this complexity; we cannot put aside the problems and the issues.

How can we meet the challenge effectively and efficiently? Can it be done without changing our traditional institutions, to warp them beyond recognition, or without subversion of our basic goals?

We look to those of you who are scientists working in these fields for suggestions, guidance and cooperation. But the final shaping of the new tools must be a joint enterprise. This is because there are just as specialized and complexed institutional practices which surround our work in a functioning democracy as there are mysterious formulas and principals in your scientific world.

I might say I consider this to be a very important session that will take place. I am very proud of this committee. I am proud of the working atmosphere, the understanding atmosphere, that has developed between the House Committee on Science and Astronautics and the scientific world. It augers well, not only for the people of the United States, but for the people of the entire world.

I realize the sacrifices you ladies and gentlemen have made, in coming here to attend these meetings; and I want to express to each and every one of you my deep appreciation, because the work that will take place, the meetings that will take place and the knowledge that will develop therefrom, benefits not only the members of this committee but also benefits the Congress of the United States.

I might say that when I was chairman of the Select Committee, that out of the meetings there was borne, in my mind, a thought that there should be a Committee on Science and Astronautics as part of the House of Representatives. I realized that establishing such a committee and appointing members to it was not going to create scientists in the sense we use that word for those who devote their entire life studying in the field of science, but I did think that men appointed to this committee would become dedicated to the legislation that came before this committee, and in that sense, they would become legislative scientists.

The reason for that is that with the conflicts, duties, and responsibilities evolving on Member of Congress, as Members are assigned to different committees, they take an interest in their committee work. They become specialists from a legislative angle in the field of legislation that under the rules of the House is referred to the various committees of the Congress.

The basis of the thought I had in the establishment of this committee, in leading the fight for it, and in giving it a broad jurisdiction rather than a limited, purely academic one, was that Members appointed to this committee would meet a challenge, not meeting once every 3 or 4 or 5 years to consider an authorization bill; but they would have constant questions arising that would challenge them, and that they would dedicate themselves to become as profound in their knowledge in the field of science as is possible from the human and the legislative angle.

So, I think this committee has justified the thought I had which developed out of my chairmanship of the select committee out of which came the Space Act with which you are all familiar.

I might say, I am proud—I repeat, I am proud—of the work of this committee, particularly so under the leadership of Congressman Miller and all of the members who have so effectively cooperated with him and who take their work so seriously and which has developed this fine atmosphere which is prevalent in this room today and which will radiate not only to the Congress and throughout the country, but throughout the world.

But, ladies and gentlemen, I, as Speaker of the House of Representatives and personally as John McCormack, I want to express my profound appreciation for the deep interest each and every one of you have taken in this and in making the sacrifices I know you have made to be here on this occasion, and to attend the 11th meeting that will take several days to accomplish.

I thank you for inviting me to join with you at this opening session. I look forward to talking with you more in the meetings that will take place during the next several days, and I am confident out of these meetings that will take place will come contributions that will be beneficial, not only to the United States of America in a limited way, but beneficial to the entire world. Thank you very much. [Applause.]

Chairman **Miller**. Thank you very much, Mr. Speaker, for your continued interest. We again thank you.

It is my privilege to now introduce the ranking Republican member on the committee. May I say, in the 11 years of this committee's existence, partisan politics have never entered into it. We have tried to work together, and have successfully done this.

It is a great privilege to introduce Mr James Fulton, the ranking Republican member of the committee. [Applause.]

REMARKS OF CONGRESSMAN JAMES G. FULTON, RANKING MINORITY MEMBER, COMMITTEE ON SCIENCE AND ASTRONAUTICS

Mr. **Fulton**. I want to agree with the chairman and thank him for the introduction.

You know, space is a mighty big place. Since the Speaker started us off on space, we found it hasn't been big enough for politics yet. As a matter of fact, on this committee, the votes have not been political. It is an amazing thing that in 1961, when President Kennedy said that within this decade we would land a man on the moon and safely return him, the House of Representatives, in a record vote, voted 100 percent unanimously to do it. So let's give a hand to President Kennedy, the Speaker, and the Congress. [Applause.]

This is a distinguished audience, as the Speaker has said. It is a most distinguished audience. If you will look around to your right and to your left, to the ladies present, it is an audience that has been culled from the intellectual pinnacles of this country and the world.

Our permanent panelists are a great inspiration to each of us on the committee. It is always a pleasure to extend a warm welcome to you, because it is like a window for us into science. To you I hope it is a window into the operations of Congress.

As a matter of fact, this committee ought to be more than a window, and I believe it is, Mr. Speaker. I believe this is an open door.

Too many times, we have problems brought up with no direction given to the Congress as to practical solutions. It is very easy to sit in a club or in a schoolroom or among your friends and find that you all agree on something. But have you people who have never been in Congress ever gone out on a Sunday afternoon with your family and tried to decide whether to stop either for a picnic or at the little red schoolhouse? You found how difficult it is to reach a decision on the right place in the road to stop, just within a family.

There are 200 million people in our U.S. family, represented by 435 men and women in the House, and 100 in the Senate. It is up to us to work out what the directions our country should take in this tremendous expanding universe. Actually it is a fearful job and it is such a fearful challenge you wonder whether we are heading in the right direction.

I want to extend a special welcome to your new panelists and greet the members of the panel who are attending here for the first time: Dr. Bennett, Dr. Wilson, Dr. Dupree, and Dr. Pounds.

They will discover they have become part of a remarkable panel. They will also discover, as the committee members have, that the panel meetings are a rewarding personal experience.

Since 1959, the Panel has grown in value with the committee far beyond what we envisioned 11 years ago. That growth has been commensurate with the expanding responsibility of the committee in the scientific research and technology.

The depth and scope of the Government's investment in research and development has deepened and broadened the responsibilities of the legislative jurisdiction that the committee is assuming to a greater and greater degree.

I would like to add, too, that we committee members are trying to live up to this responsibility. We are visiting the schools, the universities, the scientific establishments, yes, even the foundations. I want to say to Mr. Bundy, after his bath of fire on the tax bill for foundations, that we are glad to see you come out of the heavy foliage again, even with a deep tan. [Laughter.]

And that you look in pretty good health. The foundations may be a good bit like Government agencies. They are always dying, but they never go out of existence. [Laughter.]

Today, we are beginning a meeting concerned with the management of knowledge. This topic is of utmost importance. The fact is, that our country has, in recent years, produced a flood of scientific information and innovation which is yet to be fully evaluated and digested.

The question is this: Is this a disease? Is it up to proportions where it is beyond control? Is it ravaging or is it helping?

This is an area that must be of continuing high concern to our committee, as well as to the technological managers of this new technology.

The new technology for management of information is steadily expanding at a tremendous and geometric rate. It is becoming increasingly and unbelievably expensive.

The question is, When we come to managing knowledge, can you put a Congressman in a computer? Can you put an ocean in a computer? Can you put a nation in a computer? Can you put a whole civilization in a computer?

The second question is this, Do we want to? Where does it stop? What is the relationship of science and government? What is the relationship of science and schools? What is the relationship of science and the goodly heritage I individually inherited of my own world and my own universe? How far is that going to be changed? How much is my immediate environment going to be changed for my own good, Mr. Bundy? I may not want it.

We people in Pittsburgh liked the smoke for a good many years. Didn't we, Dr. Stever? [Laughter.]

Dr. **Stever**. I wasn't there.

Mr. **Fulton**. In Pittsburgh, you might not hear talk about eliminating too much smoke, because we fear the elimination of the plants with the smoke.

So, Dr. Stever, on my advice as your counsel and as a member of the Panel, you will not answer the question. [Laughter.]

Is science going to be the handmaiden of our civilization, or is this "science" going to be the Medusa of our hates? Is science to continue to be the power behind the unchallenged engines of war, and the uncontrolled arms race, this race for human destruction? Or has the world arrived at the peak of its ability for mutual and instant destruction?

Some of us are beginning to think it has. We are getting mighty tired of $70 billion for defense and $2 to $3 billion for science for peaceful uses on the basis we have now gotten to the moon. It is all over, boys and girls, and the taxpayers are going to crawl back into their holes.

I hope you and your report will justify science. I see Dr. McElroy sitting here. I am very proud to have you here. He is head of the National Science Foundation. It is a tribute to you and to Dr. Leland Haworth, as well as this committee, that of $500 million requested last year there was appropriated $477,605,000. Give him a hand. [Applause.]

That is one of the highest ratios of a sustained budget in the Congress. The National Science Foundation is now under the authorization of this committee.

May I finish with this. Through the Panel deliberations over the next 3 days, I am confident the committee will gain new and broader insights into the problems of information management. Our civilization must confront this tremendous problem in order that, in this way, broad and effective and objective legislation can be evolved.

Thank you, and don't ever run for Congress, you scientists. You might be elected.

Chairman **Miller**. It is now my pleasure to present to you the man who has done all of the work or directed the work in putting this Panel together over the years.

You know, I come from the West, the Far West. I am old enough to remember some of the things that took place back in the early days of this century, and we had a saying out there, "You don't keep a watchdog and do your own barking." I don't try to take over for him. I am very happy to introduce to you the man who has done such a wonderful job here, and I hope that you will give him the reception he deserves.

REMARKS OF CONGRESSMAN EMILIO Q. DADDARIO, CHAIRMAN, SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

Mr. **Daddario**. Mr. Chairman, my colleagues on the committee, Mr. Bundy, Panel, our guests, ladies and gentleman, the chairman has put me in the category of a watchdog here, but, Mr. Chairman, I don't intend to do much barking.

I do, first of all, want to call attention to the fact that as we approach this new decade, a theme such as this one does point in an abject way to the great problems we face. I do hope, Mr. Bundy, it can be kept in mind as it should that the Panel with us today gives me confidence that in facing these challenges, to quote you, "that it will be done in terms that are understandable to the general public and to those with political responsibility for action," because it has been our hope and our intention that the advisory capabilities that we have developed in this committee will develop exactly that stance for this committee and for the Congress in these extremely complicated areas.

I do believe, too, that it is important that this committee, as it meets under these conditions, has a moderator who understands the subject thoroughly. I can't think of a better one than the one we have here today.

Dr. Daniel Bell is a professor of sociology at Harvard University and Chairman of the Commission on the Year 2000 of the Academy of Arts and Sciences, which shows his involvement in forecasting as a developing capability.

When someone asked him today if he was at Harvard now, he said he was of Harvard, but not at Harvard, and that is true because he is currently the distinguished scholar at the Russel Sage Foundation. He is an author, an editor, a man tremendously involved with the problems which this society and the world society, in truth, face.

I am pleased to introduce to you Dr. Daniel Bell, and to turn this meeting over to him as moderator. Now it is fully in your hands, Dr. Bell.

Dr. BELL. Thank you.

REMARKS OF DR. DANIEL BELL, PROFESSOR OF SOCIOLOGY, HARVARD UNIVERSITY, AND CHAIRMAN, COMMISSION ON THE YEAR 2000, ACADEMY OF ARTS AND SCIENCES

Dr. BELL. This is a rather unique educational enterprise, even more so by the fact that it is initiated by the Congress. It brings together Members of the Congress, members of the scientific and academic community, and an interested public to discuss, not a specific legislative issue, but a broad theme and to try therefrom to pool knowledge, provide some public understanding, and perhaps some guidelines in identifying relevant problems.

The theme here is the management of information and knowledge. We are going to organize it essentially as a seminar with two papers at each session, beginning this afternoon, and papers tomorrow morning and afternoon, and finally a seminar discussion on Thursday morning.

The theme is the management of information and knowledge. Mr. Fulton in speaking raised certain questions about goals. I thought, yes, there is one thing lacking in the topic which is the role of wisdom. The problem is how do you apply wisdom to the management of information and knowledge.

A number of years ago, Columbia University was sued by a student on the ground that the university did not provide him with wisdom. And he wanted his tuition back. The court denied his claim on the ground that a university does not provide wisdom; it only provides knowledge and information.

The question is, How do you apply the wisdom to information and knowledge? And to Mr. Fulton, therefore, I can give a bit of rabbinical wisdom, a story of a man who asked the rabbi about wisdom.

"Rabbi," he said, "you are a wise man. How do you become wise?"

The rabbi replied, "Well, you study, work hard, and gain knowledge."

The man said, "But, Rabbi, a lot of people study and work hard and gain knowledge and are not wise."

The rabbi said, "You study, work hard, gain knowledge, and have experience."

The mand said, "Rabbi, a lot of people work hard, study, gain knowledge, have experience, and are not wise."

Well, the rabbi said, "You work hard, study, gain knowledge, have experience, and good judgment."

"Rabbi, how do you have good judgment?"

The rabbi said, "By having bad experience."

So, perhaps we can pool here our experiences, good and bad, in an effort to apply wisdom to the problem of information and knowledge.

I have been asked to do one further thing which is to try to set some context in which this discussion will take place. The context I want to set it is the next 30 years—not arbitrarily, but symbolically—and the proposition I wish to put forth is that the development in which all of our efforts are taking place is the emergence of what I have called a postindustrial society.

I am trying here to identify—not the immediate political currents—but the deeper structural changes which are taking place in American society, structural in the sense of the basic social arrangements, the way in which the movement, for example, from an agrarian to an urban society is a structure change.

If one tries to identify the basic structure changes in American society, what is emerging is the idea of a postindustrial society, and these problems are unique in human history.

We can think of society in terms of preindustrial, industrial, and postindustrial. Most of the world today is still essentially preindustrial, in the immediate sense that at least 60 percent of the labor force is engaged in extractive work: mining, fishing, timber, agriculture. About 65 to 70 percent of the labor force of Asia is still preindustrial. Sixty-five percent of the labor force of Africa is still preindustrial. Sixty percent of the labor force of Latin America is still preindustrial.

Industrial societies are essentially those few on the Atlantic littoral, plus the Soviet Union and Japan, societies in which the majority of the labor force is engaged primarily in industry and manufacturing.

The United States, to some extent, is the first postindustrial nation in that the majority of the labor force today is not engaged either in agriculture and extractive industries, or manufacturing industry, or a combination of both, but essentially in services—that is, trade, finance, real estate, education, research, administration, government.

But this is not just a change in sectors, a change only from extractive to industrial to services. It is a change equally in the character of the societies themselves.

A preindustrial society is essentially one based upon raw materials, as a game against nature, and in which there is diminishing returns. An industrial society is organized primarily around energy and the use of energy for the productivity of goods. A postindustrial society is organized around information and utilization of information in complex systems, a matter which is taken up in Dr. Beer's paper, and the use of that information as a way of guiding the society.

Without the organization of information, we can no longer know where we are going to be going, and as an old Talmudic aphorism puts it, "If you don't know where you are going, any road will take you there."

You need information, knowledge, and wisdom to know where you are going, and a postindustrial society is one primarily organized because it is a society of change on the basis of information. That becomes the crucial threshold of our discussions for the next several days on the organization of information.

There is another and even more important fact about a postindustrial society. It is not just a service society in terms of where people work; it is not just an information society on the basis of organizing the flow of knowledge; it is also a society uniquely dependent upon the compilation of theoretical knowledge.

Now every society has always been dependent on knowledge in order to grow. But it is only in the last decades that we have become uniquely dependent on the codification of theoretical knowledge in order to know where we are.

This is preeminently the case in the relation between science and technology. If one takes a look at every major industry we have—steel, auto, aviation, electricity—these are all primarily 19th-century industries in their pattern of innovation and in their origin, although steel began in the 18th century and aviation in the 20th. But these were all created by talented thinkers who worked quite independently of the law of science, people like Darby in steel, Edison in electricity, the Wright brothers in aviation.

The first modern industry, so to speak, is chemistry insofar as one has to know the theoretical properties of the macromolecules which are manipulated in order to know what one is making. That is a unique relationship that is amplified by the atom bomb. It is implicated in the whole relationship to war which also creates a change of relationship of science to technology.

In effect, what this means, is those institutions primarily concerned with the codification of theoretical knowledge, become primary to society, because theory now, in effect, guides the way to practice. We have, in a postindustrial society, a reduction of empiricism and a growth of theory; theory, not only in the relation of science to technology, but also in the relation of economics to public policy. We have, for example, the extraordinary situation of a Labor Government in England deliberately engineering a recession to redeploy resources in order, in effect, to create a sense of forward movement based upon economic theory. To that extent, one finds the codification of theory becoming central.

If that is the case, it means a number of things. It means that the health and strength of the intellectual community is not only a matter of a general concern to society, but a necessity in the organization of change. It means the sources of innovation in the society come from the intellectual institutions, the universities, the research institutes, the research corporations. It means moreover that the scarcest resource to the society is essentially talent (or human capital in the words of the economists) and the husbanding of human capital, the identification of talent is a much more different cycle than that of financial capital.

We know the principles of raising money capital, which is to restrict consumption and use the results of savings for investments, but the problem of identifying talent at an early stage, whether through Headstart programs or several others, of husbanding it, monitoring it, enriching it, are essentially very difficult processes over a 20-, 25-year cycle.

The organization of human capital is also, therefore, a very real problem in a postindustrial society. To this extent, it seems to me that the kinds of problems we face are new and difficult. Every society always thinks its own problems are unique, but there are elements of interdependency and complexity in a postindustrial society which are genuinely novel in history. This makes our deliberations in the next 2 or 3 days more pregnant for the coming years in being able to guide our lives and the lives of our children.

That, I would propose, is the study to which our discussions might take place.

We have about half an hour for some preliminary discussion this morning, based upon the text of Mr. Bundy's remarks. Insofar as this is an educationally comprised seminar, we are going to try to run it on a more relaxed basis than a congressional hearing.

The floor is open particularly to members of the panel who want to comment, and even to the other members.

Dr. Brown.

Dr. BROWN. Mr. Chairman, in the light of Mr. Bundy's stress upon the need for international cooperation and the environmental problems and in the handling of information dealing with the environment, I would like to draw the attention of the committee to several developments on the international scientific scene which I believe are relevant.

The International Council of Scientific Unions has conceived of and operated a series of collaborative scientific programs which have resulted in the accumulation of essentially environmental information, starting off with the International Geophysical Year, which resulted in the establishment of three large units for data storage, then the collaboration of the Indian Ocean expedition, which in turn was followed by the international biological program, which is still moving forward.

More recently, the International Council of Scientific Unions has joined forces with the World Meteorological Organization, which is a governmental body, intergovernmental body, to develop the global atmospheric research program which Tom Malone on this Panel was instrumental in starting.

Going one step further, at the last meeting of ICSU Executive Committee, a new entity known as the Scientific Committee on Problems of the Environment was created, which, on an international basis, including both East and West representation, will try to come to grips with some of these problems on a continuing basis.

In addition to this, the International Council of Scientific Unions has joined forces with UNESCO in the development of a study which is now nearing completion, assessing the feasibility of establishing a worldwide scientific information system, making use of existing national systems, and attempting to forestall the development of national systems which are incompatible with each other so you cannot read between one and the other.

This particular study is now nearing completion, and already it has had a remarkable effect in bringing in these systems certain inventions, certain modes of operation, between existing private and national systems which would not have been possible otherwise.

I should say, that in this connection, for the first time we have had two organizations sitting down together in the same room which could not be brought together before; namely, the OECD and the Eastern European counterpart, the Mutual Security Organization.

Thank you, sir.

Dr. **Bell.** Yes, sir; Mr. Goland.

Mr. **Goland.** We seem to have, to some extent, changed the topic of this meeting; but I would like to say one word in regard to Mr. Bundy's remarks about the question of model building and pollution and in this general area.

We must recognize there are certain problems in pollution which are indeed international. Most of them are not, of course. There are certain problems of pollution which are national, for one reason or another. The production of antipollution devices, for example, in the automotive industry, is a national problem by virtue of the method by which automobiles are produced. But in the end analysis, problems of pollution really come down to local problems.

The problem of setting a pollution standard for an industrial plant on the Houston Ship Chanel is, of course, quite different than the problem of pollutants which are emitted by another type, but equally offensive, plant, but in a more isolated area, less industrially populated area of the country.

But behind all this, of course, is the need, in order to study these questions, of the models which Mr. Bundy has rightfully emphasized. It is an impression of mine and others, for example, that there are large resources currently being expended in the direction of the measurements which are not guided adequately by model building and which, therefore, will probably not turn out to be as useful as they should be and not because of any lack of standardization in moving from one part of the country to another or one part of the world to another, but simply because they are not based on even an adequate appreciation of available theoretical models.

I think, therefore, that the model building on the basic data, the basic understanding, is something which is of national and international concern. Isolated problems must be the subject of national and international standardization, but in the large sense it is important to remember pollution is a local problem: and while we must supply the information and understanding for the local agencies to come up with a valid and adequate program, we must not think of standardization in the sense of uniform standards which will not accomplish what we are after.

Dr. **Bell.** Would you identify yourself?

Mr. **Knox.** The name is Knox, from McGraw-Hill.

I would just like to comment a little bit to Mr. Bundy's speech and to Congressman Fulton's remarks with respect to the management of information.

Mr. Bundy referred to the environmental pollution, and Congressman Fulton questioned whether or not we really had a disease here, and I must confess I have written a little essay called "The Pathology of Information," directly responsive to the Congressman.

So far, it is unpublished due to the information overload and various things, but I do want to ask if the panel and members of the committee would draw back far enough from the specific environmental pollution problems we have identified, of air and water and similar physical things, and consider whether or not the communication environment itself isn't also in a state of pollution and whether we should examine here and consider ways to make that environment a little bit more responsive to human needs.

I pose that as a question. I have no answers.

Dr. **Bell.** Mr. Knox is raising the question of a traffic manager somewhere for the flow of information in this society. It is a problem to come back to with Dr. Beer's paper on information overload this afternoon. We are open for some more comments or questions, particularly on Mr. Bundy's opening remarks.

Dr. **Zucrow.** I am very interested in what Mr. Bundy has to say, and I agree in general with much of what he said; but I get back to your remarks, Dr. Bell, about wisdom.

I have been exposed to information, and I have seen people operate on information that led me to coin the word "Gigo" for the computer, meaning "garbage in, garbage out." I have seen many decisions made purely on the fact that what was put in by the programer was really garbage, because he didn't have the wisdom to understand what he was programing. I think it is extremely important that whoever sets up this model or group of people must be people who have had experiences which will help them set up a model that fairly accurately represents the thing they are studying; because if you are going to play with a model that is not fairly representative, what you will get out of it will be garbage.

Dr. **Bell.** Yes, sir. Will you identify yourself?

Dr. **Tribus.** I am Myron Tribus, Assistant Secretary for Science and Technology in the Department of Commerce. I think that Mr. Bundy has very well identified the chief contribution which computers are making and are about to make to the resolution of important social problems, and that is their use in the simulation of systems. But, more importantly, and a point which was only touched on very lightly by Mr. Bundy, these simulations can be explained to the noncomputer experts and can form the basis for collaboration by various contending parties.

The personnel of the Bureau of Standards have participated in the development of games which can be played by ghetto residents, city managers, Government representatives, industrial representatives, and through the playing of this game, through the use of the computer to act upon the logic of the game as the people perceive it, the groups that before had no way of communicating, now have the means of communication.

It seems to me that the fostering of the ability to do this is an important task for those of us who would like, in one way or another, to lead society.

The question I raise particularly for Congressman Miller and Congressman Daddario, who have ever so much more experience in these matters than I, is how do we get on with what Mr. Bundy has described as a first priority task?

How do we get on with the development of more people who can do this, and of more ways and more forms for this kind of simulation to draw in the participation of those who are not computer experts, but who must participate in the resolution of the problems because, as has been said by Dr. Zucrow, the computer experts themselves do not have the wisdom to do it?

Dr. **Bell.** We don't have much more time before the end of the session. I would like to ask Mr. Bundy to respond to some of these comments, and then we will adjourn for lunch.

Mr. **Bundy.** I have said more than I knew in my opening remarks, so I will be brief in extending them.

I strongly agree that communications is itself a critical problem. You have a brilliant and lively paper on that subject for discussion this afternoon, and I would only say for myself that I do believe that, in this question of new ways of framing the way we think about information, we should recognize that "overload" and not inadequacy is much the more important part of the problem for the ordinary man dealing with ordinary questions, making choices and judgments. In "overload," we do have a central and a critically important problem.

If I may connect that to the question of the environment and how we may improve it or prevent further deterioration, we have a great deal of discussion on how tough this problem is and how urgent it is and very little discussion of how you get from point A to point B, still less, who makes that decision and how things actually happen.

This is in part because we are in danger of living in a society in which stating a problem is confused with solving it, and in danger of living in a society in which to assert concern is to accomplish a result or appears to be the same as to accomplish a result; and the reason for that, in part, is the overload of information whose relevance and order and whose sequence and relation to performance becomes harder and harder to assess.

I share the view that much of the pollution problem is a local problem. Many of these local problems, however, will turn out to have regional and even national aspects to them. I certainly will take Congressman Fulton's word that they like their dirt in Pittsburgh, but not everybody likes it and not all the time. One of the reasons they like it is it gives them a certain competitive advantage in other respects. This is true in many other cities. You mention the Great Lakes and pollution in the Great Lakes, and you can easily find yourself faced with the contention that the pollution of the Great Lakes is the prosperity of the cities along the shorelines.

If there is to be a rearrangement of incentives which gradually cleans the lakes, I won't bother with Pittsburgh, Mr. Fulton.

Mr. Fulton. Pittsburgh is not any less clean that New York City.

Mr. Bundy. That is not saying very much. [Laughter.]

If you have any larger claims to make for Pennsylvania, I suggest you make them. [Laughter.]

You are going to get processes of choice which have this result, so that you probably need to note a national framework of incentives and disincentives so that you can get away from situations in which it is asserted, rightly or wrongly, that the whole economic life of an area is dependent upon allowing certain kinds of things to continue.

So I think there is a connection between the local, the regional, and the national which will turn out to be quite consistent when hard choices have to be made. We have a very good example with the automobile industry, with which the Ford Foundation is unconnected. I forbear to comment further on that.

I share the views that garbage in means garbage out. It is even worse than that. You can put information which, in itself, is good—and I am sure Dr. Zucrow agrees on this—in, and if it is not arranged in a rational connection to what actually happens in the process which you are trying to effect, you can get garbage out in terms of its practicability and in terms of the impression which it leaves upon people of the results.

Finally, I think that games and the process of models will turn out over time to be a much more familiar and useful part of behavior than they have been in the past. Yet it is a tricky business. I have seen many games played and they are or can be an extremely misleading guide to the processes of behavior, because it is so difficult in that area, and I suspect in most important areas, to include really comprehensive and flexible parts—not only with respect to the situation with which you are confronted, but the process by which a decision will be made on that situation.

I can remember going over to the Pentagon in the years I was in Washington to one of these very elaborate and highly classified war games. There was one very distinguished military officer who used to come quite often, and along about the middle of the third act he always had the same two-word speech "Nuke them," he would say. "Nuke 'em." I don't make any difference what the input was; the output was the same.

Using models, therefore, does not let you off the hook of judgment and computers are not going to prevent prejudice, except over a fairly long period of time and with a good deal of sympathetic understanding from those who are not themselves technicians.

Now I have said twice as much as I know, and I am stopping.

Dr. Bell. Thank you very much, Mr. Bundy.

Thank you all, ladies and gentlemen, for coming.

We will now adjourn for lunch, and reconvene at 2 o'clock.

(Whereupon, at 11:55 a.m., the subcommittee meeting recessed for lunch, to reconvene at 2 p.m. the same day.)

AFTERNOON SESSION

Chairman MILLER. I wish to acknowledge with pleasure the presence of 16 Members of the Canadian Parliament and high officials of the Canadian Government who are here.

I particularly would like to welcome Senator Gosart and Dr. Solandt, head of the Science Policy Council, previously a guest panelist at one of our past panel meetings.

Next I would like to express gratification to the U.S. scientific attachés from 18 posts throughout the world now in Washington for their annual conference. I am particularly grateful they are able to spend these next 2 days attending this meeting, and I would now like to turn the meeting back to Dr. Bell.

Dr. BELL. Thank you very much, Mr. Miller. The topic this afternoon is on "Computers, Communications, and the Economy." We are going to have two papers, one by Mr. Herman Kahn and the other by Stafford Beer. We are going to have a discussion of Mr. Kahn's paper after his presentation and then have a discussion after Professor Beer's paper.

I shan't take much time to introduce the speakers in terms of their biographies. Their formal biographies are available to you for those who would like to see it in the biographical briefs of participants, which is available here.

About Herman Kahn, I should say one or two things which are special. The primitive psychology always knew that if you knew the name of a man, you controlled his destiny or knew his destiny. There are a few people whose names are perhaps known really so completely, aware of the destiny of that of Kahn, because those who know the origins of the name, at both sources, will know "Herman Kahn" means actually "warrior chief."

And Herman Kahn has been in his lifetime a warrior chief, a chief engaged in scientific studies and now in future studies. You may also have seen the fact there are some slides which will be presented here, which will be shown against that wall (pointing).

This comes from an old experience of Herman's in this regard. It was once said about Herman that he could talk faster than you can hear [laughter].

And in order to slow him down, somebody has advised the proposition of having him put slides on the wall so while he talks you can read, and then it becomes a race of finding out whether you can hear faster than he can speak, or whether you can read faster than he can talk.

This will be part of the latent experimenting on this afternoon. Mr. Kahn.

STATEMENT OF HERMAN KAHN, DIRECTOR, HUDSON INSTITUTE, CROTON, N.Y.

Mr. KAHN. I actually do have a problem. When Mr. Wells asked me to give a talk here, he said, "You don't have time to be bound by the topic." I understood that ahead of time. "But you must be bound by time," he said, and I said, "I misunderstood that ahead of time." There is a talk which I put together a few months ago, basically an attempt to show the main forces in the change of our culture over the next decade or two, which is a minimum 2 hours' talk. I am going to give today in slightly under 60 minutes. I will do it the easy way by talking more rapidly.

You will get a chance to know what I should have said by looking at the slides. Can we turn the two machines on?

I am starting off with a chart which we used to call a surprise-free projection of the rest of the century, which really means the next decade or two.

CHART 1—Relatively A-Military, Relatively A-Political, "Surprise-Free Projections" of the Most Significant Aspects of the Final Third of the Twentieth Century

1. Continuation and/or topping out of *multifold trend.*
2. Onset of *post-industrial culture* in nations with 20% of world population and enclaves elsewhere.
3. "Political settlement" of World War II—including *the rise of Japan* to being the third superpower (or near superpower) and the reemergence of "Germany".
4. With important exceptions, an erosion of *the twelve traditional societal levers* and a corresponding *search for meaning and purpose.*
5. The coming *1985 technological crisis*—need for world-wide (but probably ad hoc) "zoning ordinances" and other controls—a possible forced topping out of No. 1 above.
6. Onset and impact of *new political milieu.*
7. Rise of a *"humanist left"*—*"Responsible center"* confrontation—particularly in the high (visible) culture.
8. Increasingly "revisionist" communism, capitalism, and christianity in Europe and Western Hemisphere.
9. A general decrease in consensus and authority—a general increased diversity (and some increased polarization) in ideology, in value systems and in life styles.
10. Increasing problem of *trained incapacity* and/or illusioned or irrelevant argumentation.
11. World-wide (foreign and domestic) "law and order" issues.
12. Populist and/or "conservative" backlash and revolts.
13. Better understanding of & new techniques for sustained economic development almost everywhere.
14. High (1–15%) annual growth in GNP/CAP almost everywhere.
15. World-wide capability for industry and technology—recently a growth in multinational corporations and conglomerates.
16. Much turmoil in Afro-Asia and perhaps Latin America.
17. Nativist, messianic, or other "irrationally" emotional mass movements—general decrease in rational politics.
18. A relatively multipolar, relatively orderly, relatively unified world—i.e., enormous growth in world trade, communications, and travel; limited development of international and multinational institutions; some relative decline in the power, influence and prestige of U.S. & U.S.S.R.; new "intermediate powers" emerge: e.g., E. Germany, Brazil, Mexico, Indonesia, Egypt, Argentina, etc.; a possible challenge by Japan for world leadership of some sort, China and Europe both rise and fall.

Mr. KAHN. There are a number of specialized terms on the chart. First of all, the concept of the projection is simply some more or less mechanical or esoteric method of going from a past trend to a future trend. There is no assertion of validity.

We call this, you note, a "surprise-free projection." Normally if I want to appear modest, I point out that this concept is a very modest one. It is similar to the naive projection in economics, but a little more complicated. In the naive projection in economics you keep certain variables constant and let the others rip. In a surprise-free projection you put in whatever theory you believe. If events turn out according to the theory, you should not be surprised—it was your theory.

We usually add, or the Hudson staff people do, a remark to the effect, "the most surprising thing that could happen is no surprises." It really would be shocking if one laid out this whole panorama, the next 33 years and then it all happened as laid out.

I have been looking at this chart for some years now. I now believe that the events of the next decade are going to be something like this chart. That is called ego-involvement, and there are all kinds of psychological mechanisms at work here—or so many on the Hudson staff tell me. I, however, judge this belief of mine to result from an analysis.

Now, if I compare this surprise-free projection with the *first* third of the 20th century I would be tempted to dismiss it right away as being sheer nonsense, since almost nothing happens. In the first third of this century we had World War I. We had the triumph of democracy over monarchy. We had the rise of communism. We had the great depression, we had the rise of fascism, there is nothing comparable to these issues in the surprise free projection. In fact it is a very dull chart as compared to the first third of the century.

It is also a very dull chart as compared to the *second* third of the century. There we had the successes and fall of fascism, communism in China, World War II, decommunization of the world and other events.

In effect I am now suggesting that for the first time in the 20th century, one would go out and buy a map at the corner drugstore, and it should be a pretty decent map some 30 years later.

I would like to make an analogy with the termination of the French Revolutionary Napoleonic Wars. If you had gone to Vienna in 1815 and asked the people there, what do you expect, they would have told you 25 more years of revolutionary violence like the last 25. In fact they had 100 years of relative peace.

It is true that they had 1830 and 1848, but they were basically evolutionary, not revolutionary—there were small wars, Crimea, Franco-Prussian War, but nothing to tax them. I think we are in for a period of relative calm such as 1815 to 1914.

I remember about 6 years ago I made a bet with a number of people that there would be no intense crisis, as intense as the recent Cuban missile crisis, or the 1960 Berlin crisis, which bet I collected on.

For what I expect to happen the 1815 analogy is very good. What happened from 1815 to 1914? First of all you had the industrialization of Europe. In the formulation of chart 1 this is what I call the continuation of the multifold trend. I will now show you on chart 2 some 16 aspects of the trend which I will argue have been characteristic of the Western culture for the last 500 or 1,000 years.

CHART 2

There is a basic, long-term, multifold trend towards—

1. **Increasingly sensate (empirical, this worldly, secular, humanistic, pragmatic, manipulative, explicitly rational, utilitarian, contractual, epicurean, hedonistic, etc.) culture—recently an almost complete decline of the sacred and relative erosion of "irrational" taboos, totems, and charismas.**
2. **Bourgeois, bureaucratic, and "meritocratic" elites.**
3. **Accumulation of scientific and technological knowledge.**

4. Institutionalization of technological change, especially research, development, innovation and diffusion—recently and increasingly a conscious emphasis on synergisms and serendipities.
5. World-wide industrialization and modernization.
6. Increasing capabiilty for mass destruction.
7. Increasing affluence and (recently) leisure.
8. Population growth—now explosive but tapering off.
9. Urbanization and recently suburbanization and "urban sprawl"—soon the growth of megalopolises.
10. Recently and increasingly—macro-environmental issues (e.g. constraints set by finite size of earth and various local and global reservoirs).
11. Decreasing importance of primary and (recently) secondary and tertiary occupations.
12. Increasing literacy and education—recently the "knowledge industry" and increasing numbers and role of intellectuals.
13. Future-oriented thinking, discussion and planning—recently some improvement in methodologies and tools—also some retrogression.
14. Innovative and manipulative rationality increasingly applied to social, political, cultural and economic worlds as well as to shaping and exploiting the material world—increasing problem of ritualistic, incomplete, or pseudo rationality.
15. Increasing universality of the multifold trend.
16. Increasing tempo of change in all the above.

Most of the aspects go back 600, 700, even 900 years or so, but some only go back 200. Our most basic assumption is that there will be a continuation of this trend. That is not a brave, courageous remark, saying what is going on for 500 to 1,000 years will continue. But there is a certain amount of courage in it. There has been ebb and flow in this trend. We are suggesting it will flow. It will go in full tide.

Now, if I had time, I would give you literally 20 scenarios I have written in another document here on how the trend might change. Since I am making the reverse prediction, I cannot argue it as an absolute. I am just saying it is reasonable.

The next trend we can expect is the postindustrial culture, as on chart 3. This is a phrase which was first used, I believe, by Dr. Bell. I used to use the postmass consumption, or post-American culture but I defer. I think his is the better term.

CHART 3—The "Emergent U.S." Year 2000 Post-Industrial (or Post-Mass Consumption) Society

1. Most "economic" activities are quaternary (largely self-serving, services to self-serving activities, or services to such services) rather than primary, secondary, or tertiary (production-oriented).
2. Per capita income $5,000 to $20,000/year (or about 10 times industrial and a hundred times pre-industrial.
3. Narrow economic "efficiency" no longer primary.
4. Market may play diminished role compared to public sector and "social accounts."
5. Official floor on income and welfare for "deserving poor"—effective floor for others.
6. There may be more "consentive" and anarchic type organizations (vs. "marketives" and "command systems").
7. Business firms may no longer be the major source of innovation or center of attention.
8. Widespread use of automation, computers, cybernation.
9. "Small world" (but "global metropolis" not "global village").
10. Typical "doctrinal life time" two to twenty years.
11. Learning society—emphasis on late knowledge, imagination, courage, and innovation—de-emphasis on experience, judgment, and caution.
12. Rapid improvement in institutions and techniques for training and teaching—"education" may lag.

13. Erosion (in some upper and upper middle classes) of work-oriented, achievement-oriented, advancement-oriented, deferred gratification values.

14. Likely erosion (at least in these same classes) of the other eleven "traditional levers."

15. Much apparent "late Sensate chaos and polarization."

16. Sensate, secular, humanist, perhaps self-indulgent criteria may become central in important groups—at least during this transition period,

17. But the search for "meaning and purpose" will largely find at least an interim solution (or solutions).

18. This solution may contain important elements that are "against progress," against numbers 15 and 16 above, and/or against "western culture."

We argue here that by the year 2000, about 20 percent of the world should be living in advanced countries but ones in which industry—manufacturing and construction—are no longer the central activities. As you know one can define primary activities such as food gathering, fishing, hunting, forestry, and farming. That is primary.

Then one has secondary, manufacturing-construction. We have for some time now in this country been in a tertiary economy—services. But basically services to the primary and secondary sections. I will coin a term, "quaternory," in the obvious fashion, to suggest a different kind of service economy.

There are services that are either done for their own sake, or services to such activities, or services to such services. The next thing is most interesting in terms of immediate impact. The really unexpected event in the 19th century was the rise of Prussia. As far as I know nobody in the first half of the 19th century suggested it.

That event dominated the history of the late 19th and the first half of the 20th century. A similar event is occurring to us now, and most people do not recognize it, though they pay lip service to it. This is the unbelievable rise of Japan.

In the fifties, the Japanese economy a little more than doubled in size. That is a fairly impressive performance, but other countries have done it. In any case it was not very important. It went from small to medium. In the sixties the economy increased by something like more than a factor of three. That is impressive, particularly on top of the fifties performance.

It went from small to large, starting out with, you know, something well below Brazil, if you will, and passing England, Germany, and France. It is now the third largest economy in the world.

The current belief is that in the seventies it will increase by a factor of between three and five. There are a number of quite competent people who will stand behind those estimates. I don't care which; give it a factor of three; Japan still grows from large to gigantic.

When you grow from large to gigantic, you make waves, you take up room, in a way you don't when you grow from small to medium, or medium to large. At Hudson, we are starting a study of the 1975–85 period for a number of businesses, and the first thing we noticed is the unbelievable impact of Japan on all kinds of American goods and industry, both domestic and in terms of foreign competition.

It was interesting to me that if you go back to the late 19th century, you will find that the rise of Prussia had a very similar character. The British could easily see that Prussia was going to pass them. They were growing by 1 or 2 or 3 percent, the Prussians did much better, but they were very friendly with Prussia.

Later, in 1890, when the Prussians dropped Bismarck and decided to build a navy, the challenge became very sharp, the British made up with a 500-year-old enemy, France, and World War I was on its way, and a good deal of 20th century history.

One can characterize the major problem of international policy, I would argue, over the next 10, 20, or 30 years, as that of relations between the United States and Japan. We might encounter the equivalent of Germany's making a navy—an irrevocable step of that sort.

CHART 4—An Interesting Trend Among Progressive Upper- and Upper-Middle-Class Young (Under 30?)

In the U.S., in much of Western Europe, in such Latin American countries as Mexico, Venezuela, Chile and Colombia, and (before August 1968) in parts of Eastern Europe there was, in these classes—among other things—an important tendency toward:

1. **A basic change in traditional values**
2. **An erosion of old value**
3. **A search for new values**

The above processes are particularly likely when the parents had themselves been leftist when young or even just held, when young, such common intellectual values as relativism, cosmopolitanism, anti-militarism, social democracy, pacificism, and reformism—did reasonably well economically and socially as adults, but never really changed their minds. Thus they often feel they must have sold out—or at least compromised their ideals (and their children agree).

An even more dramatic situation occurs when the above values were held by the elders from 1920–1940, suppressed from 1940 to the early '60's and then revived—in increasingly intense forms.

On chart 4, I am coming to the first issue which is really directed, I think, to the subject matter of today. I am talking mainly about people under 30, though some over 30 as well. I am talking about the upper middle class in the United States, some in Western Europe, and in such Latin American countries as Colombia, Venezuela, Mexico, Chile, and before the intervention in Czechoslovakia, and, to some degree, in Japan.

The upper middle class here is not an income definition; it is an attitude. Usually, I think, in the northern United States, $5,000 to $10,000 a year is below middle class. In the Middle West, the Southwest, this income is low middle class. But many a Jewish schoolteacher in New York making $6,000 a year is actually in the upper middle class. It is a matter of attitudes.

Here is a minor test which may amuse you. There are a number of different attitudes which are correlated in class practices. In the lower middle class, when two married couples go out together, husbands and wives sit together. In the upper middle class, they tend to exchange wives. You can now place yourself.

But I believe that is a much more accurate indicator of what I am talking about than income. There are really a number of different things going on. One is the basic change in value, as I will show in a moment. The second is an erosion of what I call the 12 traditional levers (chart 5) and finally a search for meaning and purpose.

CHART 5—The Twelve Traditional Societal "Levers" (i.e., traditional sources of "reality testing," social integration, and/or meaning and purpose)

1. Earning a living.
2. Defense of frontiers (territoriality).
3. Defense of vital strategic and economic interests (or possibly vital political, moral, and morale interests).
4. Religion.
5. Tradition.
6. Other "irrational" and/or restricting taboos, rituals, totems, myths, customs and charismas.
7. Biology and physics (e.g., other pressures and stresses of the physical environment, the more tragic aspects of the human conditions, etc.)
8. The "martial" virtues such as duty, patriotism, honor, heroism, glory, courage, etc.
9. The manly emphasis—in adolescence: team sports, heroic figures, aggressive and competitive activities, rebellion against "female roles"; and adulthood: playing an adult male role.
10. The "puritan ethic" (deferred gratification, work orientation, achievement orientation, advancement orientation, sublimation of sexual desires, etc.).
11. A high degree (perhaps almost total) of loyalty, commitment and/or identification with nation, state, city, clan, village, extended family, secret society, and/or other large grouping.
12. Sublimation and/or repression of sexual and aggressive instincts.

I want to emphasize that I am only talking about 15 to 20 percent of the population here. I am talking more about the young than the old. But they are an important 15 to 20 percent, because they tend to run the country. The forgotten man is like 50 or 60 percent of the country. These statements are largely not true of him, as far as we can tell.

In an article written in 1955 in Fortune magazine it is suggested that in about 1980 space runs out on all kinds of issues—living room runs out. I have here, in a paper of which I unfortunately have only one copy with me, a list of some 80 issues which seems to more or less peak around the mid-1980's. These run all the way from different kinds of pollution, to weapons of mass destruction, to genetic engineering issues raising all kinds of private issues, to better living through better chemistry—drugs. All of them seem to somehow or other reach critical points around 1980 or 1990. If you are kind of a mystic, or a gotterdammerung type, you might say the world was only designed to last to the year 2000 or to 1980.

Some of these problems can be overstated. I remember giving a talk in 1967, where I suggested pollution was to be the big issue coming up. I said that it will be a very hard issue to exaggerate, but people will succeed in exaggerating it—they did.

You can today pick up any magazine and you will find articles saying that we are drowning in our own garbage, or about the coming death of the seas, or the coming end of the atmosphere. There is all kind of apocalyptic language. I had a girl go down to the magazine stand, and she said about half the magazines have articles on pollution, even Cosmopolitan, and so on.

This is only one aspect of this technological crisis. There are many other aspects. I repeat, many of them are hard to overstate. People have succeeded in overstating them. That doesn't mean they aren't serious. They may be even more serious than they say in their overstatements, so to speak, when you look at it seriously.

I will try to say a few things about this particular issue. I am not going to spend any time on the rest of these items on the charts. They are all to me rather interesting, but I avoided the items more or less in terms of interest to out study, and I thought these first five charts were the kind of things that were going to be useful in setting a context for discussion here.

That is why I ran through them quite rapidly. This is the long-term multifold trend (chart 2) which I claim is going on in Western culture for about 1,000 years. If you are a macrohistorian—there are about 10 of them—you often impute a lot of political significance to this trend. I am going to leave all of that out. As far as I am concerned the first item on the list is the increasing secularization of modern culture, the loss of content in all forms of authority.

I don't think there is any necessity to go through this list in any detail. Anybody can read the newspapers for the last 10 years and should be familiar with every item on that chart. There are things one can say about it that are interesting, and sometimes controversial.

I will just comment on items 13 and 14 of chart 2. There is a good bit of future-oriented thinking, discussions, and planning today—that is what this meeting is about—and some improvement in methodologies and tools, and distinct retrogression. In many ways the planners are not so good today. We have a phrase we call trained incapacity which describes the inability of the products of modern universities to see many of the important kinds of issues here.

Now, the phrase comes from Veblin, when he was describing partly the training of engineering capacity, and partly talking about the wider kind of thing. Everybody of course has trained incapacities. But as I gave a talk at the recent AAF meeting last month in Boston, it is rare that people have trained incapacities in directing the main issues of their profession.

To some major degree that is happening today in a good deal of future-oriented thinking, planning, and discussion. Part of this is indicated by reason 14, increasingly applied to social, political, cultural, and economic world as well as to shaping and exploiting the material world.

I will come back to these issues if I have time later. Let me, however, jump into the concept of the postindustrial culture. The phrase attempts to describe a change in the condition of mankind, which is about as big as any change the history of the world has ever seen.

Sometimes when I discuss this subject I deliberately use the most pretentious language of which I am capable. Sometimes I use tricks. If you ever want to be, say, impressive in a public speech sometimes, you use tricks. You can use very large numbers, and refer to the fact that there are 100 billion stars in the galaxy.

Not many people use 100 billion in their lives, it looks very big. Refer to the fact there are 100 billion galaxies in the universe, that is even bigger. Refer to the fact that man has been on earth for 1 or 2 milion years, that seems to indicate great depth, you see.

Let me try that technique. Let's see if this idea is right. Man has been on earth 22 million years. I went to the trouble of examining every one of those years rather carefully.

I found only two incidents worthy of note, and the rest a lot of trivia. You would be startled how much trivia. If you are a religious individual you must add a third incident, but since we might disagree what that third incident is, I will leave it out.

I am referring, of course, to the Covenant of God with Abraham—

Let me discuss this, as shown on chart 6. First the agricultural revolution, some 10,000 years ago. As far as we know, it didn't change per capita income, but it changed the condition of man from primitive to civilized. "Civilized" means civic culture, living in cities, and that is a big difference.

CHART 6.—1 WAY TO LOOK AT MAN'S ECONOMIC PROGRESS

Annual per capita product in 1965 dollars	Economic system	Leading sectors and most of development
$50 to $200	Preagricultural or primitive	1st 500,000 to 2,000,000 years.
	Preindustrial or agricultural	8th to 1st millenium B.C.
$100 to $300	Industrial revolution	1760 to 1790.
$200 to $1,000	Industrialization	19th to 21st centuries.
$500 to $2,000	Mature industrial	Mid 20th to 21st century.
$1,000 to $10,000	Mass consumption	Do.
$5,000 to $20,000	Postindustrial	21st century.
$50,000 (?)	Almost posteconomic	22d century. (Assumes average annual increase in GNP/CAP of 2.3 percent or so.)
(?) to (?)	(?)	23d century.

Instead of 10, 20, 30 people in the farm you have one man in the city. To some reasonable extent the per capita income, say, was $150 or $200. This is a reasonable remark although misleading. No culture had much over $200 of per capita, none dropped much below $50, that is normally, until England in the 18th century had the industrial revolution. Among other things, per capita income increased to a factor of 10, $500 to $2,000.

If you want to get a picture of what we mean by industrial culture today think of Europe in the 1950's. Southern Europe was $500 per capita; northern Europe $2,000. More important was style of life, culture; but per capita income is one of the pegs that is important.

It is now believed that the next 10, 20, or 30 years, the postindustrial culture, will see bigger changes in man's condition than these first two. Postculture income goes up by another factor of 10, but again I say that is not a crucial issue.

The issue is that conditions of life will change. I note on that chart that if the per capita income increases by 2.3 percent a year, which isn't very much, you get $50,000 to $200,000 per capita income in the 21st century. That goes "posteconomic." I want to emphasize a good deal of what is written today about the postindustrial culture does not seem to me to be applicable to the 21st century.

If it is applicable at all it is applicable to the 22d century, another factor of the ECH. One can imagine some family that wants to spend a vacation, say, in Jupiter, can't raise the $10 million that it takes, has to be satisfied with a $1 million vacation on Mars, will feel desperately deprived; but we have trouble sympathizing.

The same way that this $50 to $200 man has trouble sympathizing with our problems. Now these two charts describe what I am talking about. The chart on the left (chart 7) schematizes it rather nicely. You see the four major periods we argue of man's history, to this coming period.

CHART 7.—*Today we tend to divide man's economic history into 4 basic stages*

Prior to 8000 B.C.	Hunting and food gathering (preagricultural and usually primitive).
8000 B.C. to A.D. 1750	Basically agricultural (preindustrial and sometimes civilized).
A.D. 1750 to A.D. 2000	Industrial (or modern and/or scientific): Industrial revolution, partially industrialized, mature industrial, mass consumption.
After A.D. 2000	Postindustrial (or postmodern and/or postscientific): Emergent, visible, (mature), (late).

CHART 8.—*Future man may use only 3 stages*

Prior to 8000 B.C.	Precivilized (2,000,000 years).
8000 B.C. to A.D. 2000	Civilized (10,000 years).
After A.D. 2000	Postcivilized, posteconomic, truly human, posthuman, Faustian, post-Faustian, Promethean, post-Promethean, godlike, truly religious (e.g. neodeist) (10 years? 100? Eternity? Until fulfillment?).

On the left, I put in a single line 8,000 B.C. to indicate the agricultural revolution; in fact, it took 8,000 years for agriculture to reach England and Spain. It is really a complicated line.

On the right—chart 8—this is not a bad way to look at the world today. Two million years precivilized, 10,000 years civilized, and then something else—I don't know whether this lasts for 10 years or 100 or eternity, it is different. Truly human, posthuman, maybe something manufactured in the laboratory.

Maybe a computer society Faustian, maybe post-Faustian. I make a distinction between Prometheus and Faust. Prometheus is a man who knows but doesn't have to change the environment. Faust is the man who is the superengineer. Anyway, we don't know what is coming up. But we do have an idea of how it started. I will get to this in a moment.

By the way, we generally refer to this chart here as the big picture. Maybe some of you have bigger pictures, if you do, I would be very interested in seeing them.

Now I would like to, in the 35 minutes remaining, go from this big picture to our considerations. Chart 3 repeated here, pictures the postindustrial culture as I would see it. There is a book being written on this. Notice the adjectives in quotes. Probability of Charles Dickens writing about the industrial situation in England. What he was writing about was the early 1800's and emerging industry.

(See chart 3, p. 29.)

He was a manufacturer and landlord, he has biases. We could, of course, avoid these biases. But he did a pretty good job, but nobody would say that he described the 20th century very well. In no sense, therefore, am I arguing this is what the postindustrial society will look like, but this is the way it looks today, and it is shaping up in the United States and Europe.

I already made the comment about postindustry. Whether or not it is postbusiness is a big issue. About 95 percent of the people who studied these problems think it is going to be postbusiness, by which they mean, typically that the university will be the center of action. And 95 percent of those who believe this are university professors. I believe the policy research institutes will be the center of action. Actually in Europe it very likely will be postbusiness, in America it may not. We have a tendency in America for businesses to enter into new areas, elsewhere considered typically government areas.

I have a few comments on the third point there—"narrow economic efficiency no longer primary"—which does not mean it is uninteresting. I would like to also make a few comments on point 10. Let me take those points in order. I will start off with the efficiency point—no, let me start off with the computer, which is point 8.

Instead of curving down as many people think, the computer curve is going up; it is going better, not worse. There is a good deal of evidence to that effect, despite a lot of articles to the contrary. You often see statements to the effect that there is a general impression there have been four computers since World War II. It is more like 10 or 11. I am distinguishing performance capabilities.

You can sense how big the computer is, how fast the thing progresses. At a factor of 10 increase in the power, is a computer five or 10 or 20 times better, taking into consideration the output programing and so on? They are making these bigger and bigger all the time.

Any time you have an increase by a factor of 10, you have a new generation of computers. There have been like, I think, 10 generations. Now, every 2.3 years there has been a change of a factor of 10. That means anything you learned 3 or 4 years ago may be obsolete today, when it comes to the current-type performance computers, and anything you learn today may be obsolete 3 or 4 years from now.

If you look at a person like a civil engineer in the United States today, a 45-year-old man will make more than a 35, a 55 more than a 45, a 65 more than a 55. That is not true in computer technology. I don't know of any formal surveys, but I have done my own, and I don't know if anybody agrees with this remark, the peak is reached at 31, 32, or 33. At that point you either go back to school or join management. You aren't with it any more.

The basic concept here is that more and more of the world will be like computer technology, less and less like civil engineering. Civil engineering is a field where experience, judgment, maturity pay off—knowledge.

Computer technology is the field where courage, originality, late knowledge, imagination, daring pay off. I will suggest that the world will move from maturity-judgment to current, late knowledge. That alone raises a problem associated with that change if it occurs.

Let me make other points. It is common to say that a computer cannot transcend humanity. There is, as far as I know, no rigorous or careful written argument to that effect.

People send me papers all the time, and I have yet to see any article which shows there are any intrinsic limitations to a computer. Now, if the current rate of progress continues, by the end of the century computers ought to improve by a factor of between 100 billion and 100 trillion. I am using American billions and trillions here, but they are still very big.

That is a very big group. It may well turn out by the end of the century we will have settled the question of whether the computer can transcend man or not, if I had to guess I would say it can, and I find this depressing. I mean by "transcend" in writing poetry, speeches—sex, too, I will come to that in a moment—painting—you name the activity.

If true, I think this will have a fairly profound philosophic impact on a lot of people. This is particularly true if we get culture computers. An article which I handed out which is a paper I wrote for the London Times, "The Impact of the Computer," I mentioned, for example, in the schools of computer instruction there is a certain tendency for the children to get fixated on the computer, if you will.

People will pick a very warm nurture, a soft and gentle voice, a computer voice. When the kid goes in and spends an hour a day, the computer always says to him, "How are you, Johnny?" Never gets his name wrong. Very pleasant with him. Never loses its temper. Will repeat over and over again, but always with a kind of a fresh interest. It says, "Goodbye, Johnny" when he leaves.

Let me say, it beats every teacher the kid has got, and the kids know it.

There was some suggestion by a psychologist who gives the computer the attributes of a woman in simplicity, saying we may be in for a problem of weaning children from computers rather than getting them to accept it. As far as I know there is no culture problems anywhere in getting kids to warm up to the computer—they like it.

Let me mention a couple other minor points here, but important in applications. In a rapidly changing field of this sort, it is very hard to get good advice if you are in business. I remember in the midfifties a large number of insurance companies, finance companies, banks, went into the computer business.

As far as I know, with the possible exception of the Bank of America, they all lost money. Many of them lost money a second time because they had to go in or lose competitive advantage; they would have been burnt if they didn't go in.

They went in too early or stayed out too long. In those cases they had generally good advice. I was recently in a meeting in Europe where people were discussing technology. A number of Americans present, perfectly honestly, argued that the technology gap existed because many American firms had large global integrated data banks which they were using in integrating management systems, to run the whole firm.

As far as I know there is no such data bank in existence, no such management bank in existence. But it is hard to find out. The people think they have it and they don't. They talk as if they have it.

I remember in the corporation I was in some years, we had some of the top men in the world in computer applications, and I guess it was 1959 to 1960. I asked when the applications will be used, and are people making money on them?

They listed something over 100. I put a girl on the telephone, and used the telephone myself, and people really didn't know. This I think in some ways, this computer issue, raises all of the dramatic issues of modern technology.

It threatens man as a unique creative individual, maybe. It presents immediate problems of choice. Information is very hard to get. And it has long-term consequences of various sorts as we use it. It may change psychology.

It doesn't raise the question of pollution as far as I know, but it may raise issues of civil rights.

By the way, I might say even today computers will probably beat almost every man in this room in chess or checkers. They cannot beat a chessmaster or a checkermaster, but very few people in the room can. You know, it can play better chess or checkers than its makers, if you see the point.

There is apparently, currently a book, the Tale of the Big Computer, I forget the author, which has a rather persuasive scenario of how computers take over, sometime in the 21st century, and that too I find is not completely impossible, the final issue of it.

Let's look at the efficiency issue now. One of the ways of characterizing Americans pre-World War I, pre-1929, was by their unbelievable mobility. You could move an American from New England to California for an extra 25 cents an hour. You probably couldn't move him back, but that was a separate issue when it came up. Today it is very different.

In a manufacturing job today, there is a whole series of issues which must be satisfied before the man asks two questions, what is the salary, what is the chance for advancement? In the past these would have been the first questions. This change in the questions indicates a change in America, which by the way is reasonably true of the lower-class American as well as upper class.

We used to ask, well, if you ever want to know the true style of people, what they really think, it is always very good to look at the third-class literature. That is not confused by either genius or creativity. It is from the cliche heart to the cliche heart. I am referring to soap operas, to the confessional magazine, to the grade C movies. Something I looked at sometime ago, I don't know the reference at the moment, was a study of the soap operas. It notices that in 1929, an American who earned $1 million and picked up an ulcer in the process was treated as a hero, wounded in the battle for success, and he got double honor because he got his wounds. This same man in 1960 is treated as a compulsive neurotic with twisted values. Send him to the hospital, he is sick. There is an enormous change.

In 1930, an American who had to choose in a conflict between job and family, between advancement and friends, always chooses job or advancement, or there is tragedy.

In 1960, unless the job or advancement is something altruistic—psychiatrists, doctors, educators, director of a Hudson institute, you must always choose family or friends. You see, it is wrong, now to sacrifice family or friends for job or advancement. This is, I repeat, a very large change in attitudes. I don't know of any survey data on it. I am sure some have been. I think it should be studied more.

I want to give a quick look at the change in value. Now, there are three things going on here as I mentioned. A basic change in traditional values, an erosion of old values, a search for new values.

I want for a moment to deal with the change. I have here a list of 26 values (chart 9). As far as I know it is exhaustive. If you are running a society, this is what I advise you to pick among. You know, you can choose, and you can choose to push some and neglect others.

CHART 9

Some important human needs and/or values—

1. Respect and recognition (competitive and mutual).
2. Proper mix of change, stability and/or continuity.
3. Rectitude, duty and responsibility (fulfilling ethical, moral and/or religious imperatives).
4. Daily activities and disciplines which are ends as well as means—which are judged to be, in themselves, fulfilling and meaningful.
5. Having status—a recognized position, role, identity.
6. Advancement orientation—enhancing one's status.
7. Achievement (gaining and using skills, meeting challenges, solving problems, creating and/or doing worthwhile or admirable things and projects).
8. Wealth (access to commercially available resources).
9. Physical well-being (safety, health and comfort).
10. Physical power (over things,—territoriality?).
11. Egoistic immortality (recognition).
12. Loyalty to or submergence in familial (shared fate, common commitment, ego-identification) structures.
13. Political representation (voting on and protection from community decisions).
14. Political power (over people and community decisions).
15. Praise, reassurance, attention, etc.
16. Justice to be done and/or morality to be made manifest—e.g., appropriate rewards and punishments for "good" and "bad" behavior.
17. Assurance and confidence about the important values.
18. Sensual satisfaction (food, sex, music, art aesthetic and pleasant surroundings and experiences).
19. Adventure, excitement, danger.
20. Friendship, companionship, affection and love (to give and/or to receive).
21. Enlightenment and understanding.
22. Play, spontaneity and self-expression (being oneself).
23. Having and sharing spiritual, mystical, and religious experiences, codes and/or fulfillment.
24. Satisfaction of feelings of anger, revenge, other hostile emotions—perhaps slightly sublimated or masked.
25. Mashochistic, sadistic, nihilistic, etc., motivations—perhaps somewhat sublimated or masked.
26. Other "perversions" (sexual, gustatory, drug, etc.)

Returning for a moment to our basic prediction, I want to talk a moment about 12 reasons why the Japanese do so well. Any one of these reasons should be worth more than half a percent of growth rate, some of them like 6-, 7-, or 8-percent better in the West. All of those reasons are fairly fundamental and basic and I don't think are going to change.

CHART 10

Twelve reasons for the likely continued growth of Japanese economy—

1. High saving and investment rates.
2. Superior education and training.
3. "Adequately capitalized".
4. "Risk capital" readily available.
5. Technological capabilities competitive to West.
6. Economically and patriotically advancement-oriented, achievement-oriented, work-oriented, deferred-gratification, loyal, enthusiastic employees—probably increasingly so.
7. High morale and commitment to economic growth and to surpassing the West—by government, by management, by labor, and by general public.
8. Willingness to make necessary adjustments and/or sacrifices.
9. Excellent management of the economy—by government, by business, and, to some degree, by labor—this results in a controlled and, to some degree, collectivist ("Japan, Inc.,") but still competitive and market-oriented (but not market-dominated) capitalism.
10. Adequate access—on good and perhaps improving terms—to most world resources and markets.
11. Almost all future technological and economic and most cultural and political developments seem favorable to continuation of the above.
12. Relatively few and/or weak pressures to divert major resources to "low economic productivity" uses.

One can put a lot of reasons why the growth rate should falter, but one could also show solutions for each of these problems. Given the combination I think they will do quite well. I won't talk about all of those reasons obviously, but let me mention very quickly items 6 and 7, to illustrate what is going on. An example is a quote about the Japanese focus on hierarchy and prestigeny by Herbert Passin (chart 11). This is the basic engine behind the Japanese concept.

CHART 11—A CRUCIAL JAPANESE CONCEPT

There is at any given moment a definable world-ranking order of such character that as between any two nations one is always higher and the other lower. It is never the case that two nations stand on exactly the same level. Even when they appear close to each other, there is always a set of clues that allow the sensitive observer to discriminate between them and see their place in the ultimate ranking system—*Herbert Passin.*

Status means you have to be top, tough, if you can do it. And they can do it. As they get closer, they get more eager, you understand. So that I would say a lot of people's arguments why the Japanese will top-out for various reasons just don't hold.

Chart 12 will give you a sense of morale. Nobody in the world as far as I know sings songs like this except in Japan, where management and labor spend 10 or 15 minutes every morning singing this kind of song.

CHART 12—MATSUSHITA WORKERS' SONG

For the building of a new Japan, let's put our strength and mind together, doing our best to promote production, sending our goods to the people of the world, endlessly and continuously, like water gushing from a fountain. Grow, industry, grow, grow! Harmony and sincerity! Matsushita Electric!

Now, it is true, many serious American organizations used to have songs like this, but they burned their songbook. There are some American organizations that sing songs like this, but they are off-key, very tuneless.

They don't do it in China either, by the way. That is an important point.

There is a very interesting point. It is clearly a sentence put together to be put to music and meticulously accurate. Let's go through it. They do build a new Japan every 5 or 6 years. They double the size of the country.

They do put their strength and mind together, unbelievably harmoniously working social group. They do their best to promote production, increasing production by 30 or 40 percent a year. Sending their goods to the people of the world. Actually, their export rate is only about 10 or 11 percent, half many European countries, but don't worry, they will get up there. It is interesting to say that that is reasonable.

Like water gushing from a fountain, that is a metaphor, grow, grow, grow, 40 percent a year, harmony and sincerity. Why would any man knock that song? Why would you knock the song?

In chart 5 we showed what I call levers, the traditional societal levers, traditional sources of reality testing and social integration in America. I want to put forth what I think is a very accurate comment about the 15 percent of upper middle class Americans, the old and the young, particularly the young, for whom these 12 levers have eroded. These are no longer felt issues that press on the individual.

(See chart 5, p. 32.)

I want to, you know, place a proposition before you. What happens to a society like the United States when these 12 levers disappear?

Well, it is happening in the United States, it will happen to the upper-middle class group, if it happens, so one wants to restrict the question. What happens to the middle-upper class group? Well, for one thing, they are bored.

One could spend obviously a lot of time explaining the various items in that chart, and describing what they mean to our culture, but I think to audiences like this, a good deal of this is self-evident, so let me go on to the next phase of what is happening to the search for meaning and purpose. This is more complicated. I wish to remind you again we are talking mainly about the upper to middle class here, 18 percent of the American market. No. 1, I think will still be a pretty big thing, but I don't think it is very important. It is like the so-called forgotten American, middle American. He is the majority of the country, but he gets very little serious treatment. I think there are reasons for that that are likely to continue for a long time to come. Neocynicism is an opposite thing, a very small number of people, very important. In this case I am taking as prototype third century Greece and bringing it up to the 20th century. Remember Diogenes, the man with the lamp? He is the second cynic, and he lived the life of a "hippie" today, except he was esthetic, disciplined, and logical, the way the hippies are not.

The word "cynic" means dog, one who lives like a dog, doing his private functions in public. Diogenes is one of the great Greeks. People made special trips to see him, and the conversation actually reported was marvelous. Alexander started out by saying if I was not Alexander, I would be Diogenes. Diogenes replies, if I were not Diogenes, I would be Alexander. Alexander looks at him and says is there anything I can do for you? This is the master of the world, a man of incredible generosity, giving away houses, gold, and everything, saving only power for himself. When he makes an offer like that, that is a serious offer. Diogenes is quoted as saying, you are in my sun, move over about two feet.

Being a human being is a very big thing in America today, neoepicureanism, family, friends, porch, garden, conversation, interpersonal relationships.

The neostoic is important here. In America, I think it is very lucky to have stoics. They were important in the Greek empire, they were essential in the Roman Empire, in a sense they ran the Roman Empire for about 300 years, and ran it very well. There is a widespread agreement there was no better period of administration in man's history. The thing ran in families. Other families may act any way they want but we keep the system running. They were pessimistic. They would never work for an empire. They were pacifistic, ran an army. Their slogan, by the way, was typical. They said they were actors in a play. It is up to the author whether the actor wins or loses. All the actor can do is the best he can do. He just can't be more successful than that. They ran the Roman Empire through the incredible skill for about 250 years.

I sometimes, by the way, give a lecture like this to American colonels, and they immediately identify with stoics. Some then get angry. When you say we are going to get ourselves killed and nobody will appreciate us? Yes. I won't do it. You can't help it. That is the way they are.

If I had to pick the mainstream of America, I would pick items 5, 6 and 7 on chart 5. This is what is going on as far as I can see. Eighty percent of the Harvard kids, prestige schools, what you read in the paper a lot, about 5, 6, and 7.

Let me define "gentlemen" for you. A gentleman is a man with many, many skills, in which he has a high degree of ability, one of which is useful. If you are in America, at that point you are turned off. If you are in Europe, that is exactly right, that is the way it should be.

The Spartans had a theory when they got rich, they would get soft, corrupt and disappear, and when they got rich, they got soft, corrupt, and disappeared right according to the scenario.

The Athenians had no such theory. The Romans had the same theory as the Spartans. When they got rich, they would get soft, corrupt, and disappear. Despite our usual lurid stories about the fall of the West that really didn't happen. They becameAthenians.

You can put it a little differently. The Spartans or the Romans stayed fit and had to fight wars. You took the wars away, they couldn't stay fit. The Athenians like to stay fit for their own sake. If you take the wars away, you go to bigger gymnastics.

One final comment. The Athenians licked everybody around except the Spartans and Romans. If there were no Spartans or Romans, they couldn't be defeated. When I gave this lecture in Moscow and Tokyo, they looked delighted. But on the history you can tell whether they are Spartans or Romans. My own guess is that they are not, but I am not sure.

This is an important issue by the way, is Darwin still here? A good deal of what I have to say here today indicates Darwin doesn't count anymore, survival of the fittest and that kind of thing. It may be wrong.

Let me hit the same issue a little more dramatically. I have here five columns that are sort of ways of living.

CHART 13.—SOCIAL AND POLITICAL IDEOLOGIES MAY EMPHASIZE

Impulse (1)	Reason (2)	Conscience (3)	Transcendence (4)	God's Will (5)
LEADING TO, AT BEST, A REASONABLE EMPHASIS ON—				
Freedom	Rationality	Loyalty	Spirituality	Revealed truth.
Spontaneity	Moderation	Dedication	Perspective	Absolutism.
Creativity	Thoughtfulness	Traditionn	Pan-humanism	Salvation.
Perceptiveness	Meliorism	Organization	Idealism	Righteousness.
Participation	Flexibility	Order	Altruism	Eschatology.
Sensory awareness	Calculation	Obedience	Mysticism	Worship.
Self-actualization	Planning	Self-sacrifice	Detachment	Awe.
Joy and love	Prudence	Justice	Reverence	Submission.
BUT WITH A CORRESPONDING POTENTIAL FOR PATHOLOGICAL DEGREE OF—				
Permissiveness	Abstraction	Authoritarianism	Fatalism	Bigotry.
Impulsiveness	Theory	Rigidity	Passivity	Fanaticism.
Anarchy	Rationalism	Righteousness	Mysticism	Righteousness.
Lawlessness	Indecision	Despotism	Naviete	Dogmatism.
Chaos	Dehumanization	Sado-masochism	Unworldliness	Hypocrisy
Nihilism	Scientism	Punitiveness	Superstition	Superstition

Column 5 is when my grandfather lived. When I was young, I thought he was in the bottom half, which is the pathological form. Now he is in the top half of the chart. He literally talked to God every morning, got His advice, carried out His instructions during the day, and reported at night. They tried to raise me in that column, but as near as I can tell, it didn't take. I was sort of raised in column 3 there.

Now, in my judgment, the Nazis are raised in the bottom half of that column, pathological form, we raised in the top of the half. Most of the people in this room are raised in column 3. Most of the school system today is mostly columns 1 and 2. The school system and the family reenforces each other. Your low-middle class is column 3, and the family so to speak, submerges the school. So there is quite a bit of change. Your hippie is column 1 and column 4, about half and half.

Column 1, if you will, is very attractive to the 5-year old. He may not like it when he is a 30-year old. The hippies don't think of the Savior, they think of themselves as John the Baptist. There is no point in asking John the Baptist what the message is, he hasn't got it. All he knows is there is a message on the way. They take that position very strongly.

Let me get to one more point here with two more charts.

CHART 14

Some areas with special technological dangers—

1. Intrinsically dangerous technology.
2. Gradual and/or national contamination or degradation of the environment.
3. Spectacular and/or multinational contamination or degradation of the environment.
4. Dangerous internal political issues.
5. Upsetting international consequences.
6. Dangerous personal choices.
7. Bizarre issues.

CHART 15

Dangerous personal choices—

- **A. Choose sex of children.**
- **B. Genetic engineering.**
- **C. Super-cosmetology.**
- **D. Lengthy hibernation or preservation of corpses for possible later revival.**
- **E. Psychedelic and other mood-affecting drugs.**
- **F. Electronic stimulation of pleasure centers.**
- **G. Other methods of sensual satisfaction.**
- **H. Dropping out and other alienation.**
- **I. Other excessive permissiveness and self-indulgence.**
- **J. Excessive narcissism.**

Here are seven areas on chart 14 regarding the technological dangers. These are the problems we expect to occur between the 80's and 90's and in the other report I have I expand each of the seven areas by giving you 10 examples on chart 15. I just took area 6 because it is easy to see what the kids are most worried about.

Then, of the personal choices, take item A, choose sex of children. There is a good chance to do it in 20 years, but complicated, artificial insemination, abortion, that kind of thing. You may be able to do it simply by a pill. If you do that, tragic. A country like India, China, I am told will have no female children at all for a long time. There is no interest. Countries like Japan, Germany, China might go to 80–120 in sex ratio. In some sense, you have no right to issue that pill.

Or take item B, genetic engineering. There is in fact a form of reproduction, which was mentioned to me, but I won't go over all the details, which gives you an idea of what is going on. This thing was turned in about 2 years ago. Scientists took the chromosome material from the cells from the intestines of a frog, put it to the fertilized egg of a different species of frog. About 2 percent of the things work out to adulthood, if you will, and produced the genetic swing of the original frog. If this thing works out, 10 or 20 years, my friends tell me that is what their expectation is, we ought to produce a genetic twin of any individual in this room, as many copies as we wish.

I said this to my wife, she got very upset. She was looking at the image of me reproduced about 600 times a year. Her position was, she wouldn't live in that world under any circumstances.

My position is, you don't want to run out.

There are all kinds of things—may I take a few minutes.

Dr. BELL. Yes.

Mr. KAHN. Let me hit the most dramatic thing on the last chart, which is also controversial, this may be hypothetical rather than real. What I am talking about is number F there, electronic stimulation of pleasure centers. The reason I want to mention it is because it really brings forth in most dramatic form the problem of the upper middle class kid. The lower class kid has no problems. The upper middle class kid without the 12 leverages is defenseless against this chart. They already know it.

Let me give you this example. A study was done 12 years ago with rats. A scientist took a rat with a pleasure center—rats have only one, as far as we know—applied it to a stimulator. Gave the rat the choice to press it or have water, food, water, sex, or rest. Some 6,000 times an hour the rat pressed the lever and ignored other choices. If you force him to take a little food, a little water, a little rest, he leads a longer and as far as we can tell happier and healthier life than the control rat. So this is the solution.

We cross-checked it. If you do things, like for example force him to take an electric shock to press that level, he will take an unbelievably heavy shock.

Some scientists believe human beings have, say, 10 pleasure centers. I say we don't know this is so, but some scientists believe it, I believe it myself, or at least I guess it. If this is true, then I give you one meaning to the problem. Your 10 pleasure buttons are on your chest, and I don't think you should play your own console. I am square, obviously, I want to be rigidly square. Any two consenting adults to play each other's consoles, and you see the conversation. Have you ever tried 1 to 5 together? I have a new composition that uses alternate 1. Get set for a mind blowing experience. I don't know if this thing will occur, but something like it is in the mill, whether it is by drugs or electronics, and this is the kind of thing which presents your young kid today with an unbelievably complicated problem. For the first time in history that I know of, you have a large number of your people, artistic, esthetic, who are antiprogress. You know the reason. There are other issues of this sort that come out. I can only say that I happen to be among those that sort of like progress on the whole. I find myself the more and more I study these problems, the more sympathetic I get to the antiprogress position.

I am not recommending it, I am not suggesting it. I am saying I would not be surprised. We actually already have it. We keep things secret from our allies, Germany, Japan, France, which our enemies, China, and Russia, know, for obvious reasons. That is an index.

It will also be surprising if that index did not contain a lot more information in the future. Thank you very much. This was a very impressive talk.

Dr. **Bell**. Thank you very much, Mr. Kahn.

We are going to try to run this as a seminar, which means that we are open for questions, comments, elaborations, et cetera.

I would just make one comment. When I saw on Herman's charts the future about postcivilized man, Faustian man, Promethean man, and even the computer-transcending man, it reminded me of a story my grandfather once told me about the time Spinoza was very upset about the mundane world around him, reground his lens and tried to reach God. Finally he broke through the barrier, finally began talking with God, talking about the nature of man, the first cause, the final cause, the infinity, transcendency. God said all of this is very pretty, but let's talk about things truly great.

Dr. Spilhaus.

Dr. **Spilhaus**. Mr. Kahn wasn't here this morning when McGeorge Bundy said sometimes we, society, confuse things by thinking that stating the problem has something to do with solving it.

This has been a most enjoyable statement of very deep problems, but I have not seen that Mr. Kahn has any proposals for their solution.

Mr. **Kahn**. That is deliberate. A place like Hudson has a number of mentally manic type people there, and the record is not immune from this disease. I have a 3-year program to be helpful. This is the first year of that program.

We have a lot of conjectures of things we think we ought to be doing. I expect to be back in about a year or two, with prescriptions, a normative statement, you know, and I can pretty well guess what it will be right now, at least in some cases.

But we want to speak about them.

Dr. SPILHAUS. Would you tell us your guess, please?

Mr. KAHN. First and foremost, I think we are going to find a reaffirmation of one of those 12 levers, you know, that I talked about, eroding so rapidly.

And when we have affirmed on an intellectual level which is respectable—I think you will find a discrediting, both deliberate by people going out and doing it deliberately, and also just by observation—of a good deal of current intellectualizing. What I mean, let me start with some very obvious points.

I had a girl spend almost 2 weeks in the public library in October 1968 on the central issues of the election, or some essential, law and order, backlash, you know, Negro issues and so on. It was rather interesting. She could find some stuff by Jim Wilson, something in the Public Interest. I think Joe Kraft, one of the columnists, also understood that law and order was not a code word grant by Negro. Today a lot of them understand that, you know. But in October 1968, the peak of the election, practically no literate man understood that. Two-thirds of Negroes were in favor of law and order by the way. To the extent the phrase was a code, it means anti-hippie, anti-new left.

Lower class middle America undoubtedly tends to be anti-Negro. Most studies indicate every year there are less anti-Negroes than the previous year. You can't call that backlash. What is backlash? A tremendous reaction of lower-class America against the middle-class America, which is white against the white. What I am saying is there will be a discrediting of a good deal of conventional wisdom.

Secondly, I can see something which I think is going to be worse, not better. I think they will call it a new political milieu here. But let me backtrack. In 1929 a series of economic cycles sort of bottomed out at the same point. You had a disaster. Government policy converted a disaster into a catastrophe.

You have social cycles, too, and certain Government policies, if you will, make their impact greater. Look at the Year 2000, which is a book I published some time ago, and many of the things we thought were going to be around in the eighties are here right now.

I think this is due partly to the Vietnamese war, and partly to Government policies. The Government simply does not know how to cope with much of the criticism, and much of its action itself alienates people. Don't increase the alienation unnecessarily.

The third most important measures has to do with changes in school, family, this sort of thing, which is hard to discuss lightly. By the way, you understand, when I am trying to define progress here, we argue these changes are necessary, but some of them are going the wrong way, so to speak, others you don't know. What we are saying is this society, taking more purposive, most responsible hands, is changing the value systems of young people. The fourth thing is already in the mill. These are large-scale programs for things like pollution and so on. And here, my major objection is that there is almost no imagination being shown. People are trying to do by sheer groups force what ought to be done by leverage, cleverness, or innocuous ways. On the other hand, they are doing research in these areas. I will put in the record the seven problems culminating about the mideighties. Most of them are here now.

A **Voice**. Do you see any relationship on your observations on the economic state of affairs in Japan and the intellectual state of affairs represented by, say, the universities?

Mr. **Kahn**. Yes, but not large. I make this as a low-morale culture, and that is in part due to the intellectual criticism, at the universities. I don't think it is a big issue.

The big things that are going on in Japan are almost unreproducible in the United States. You have to do things in a different way, completely different from you. This goes all the way from the savings rate, which runs about 35 percent, two and one-half times America, to the fact that Japanese still don't take vacations. Remember how Americans used to not take vacations? Very few Japanese Government officials ever take their 4 weeks a year. It is almost unthinkable. It is not a thing in the United States.

Why shouldn't we?

Dr. **Bell**. Dr. Brown.

Dr. **Brown**. Herman and I have been friends for many years, and I always listen to him with great respect. Sometimes I have difficulty taking him seriously.

Mr. **Kahn**. Those are the most serious issues.

Dr. **Brown**. I can't remember your exact wording, but you referred to the next 30 years as being relatively quiet times, or times of decreasing——

Mr. **Kahn**. From the political-military point of view.

Dr. **Brown**. From the political-military point of view, and also coupled with that a reduction in the explosiveness of the population growth. And I myself believe that a number of factors are coming together which may well lead us to some very unquiet times, and I would like to speak very briefly about a couple of things which you have not discussed in your own presentation, which leads you to suspect that these events are not important factors.

When we talk about economies which are 2, 5, 10 times more active, more abundant than the U.S. economy today, we must necessarily talk about the stuff that goes into the making of those economies, and this transcends knowledge, excludes things that one picks up on earth, and of course involves technology.

But let us look at the U.S. economy. We produce each year for every person in the United States half a ton of steel—half a metric ton of steel. This, for reasons which I don't understand, and I don't think are very clearly understood at all, this has leveled off in the course of the last 25 years, and it has been virtually constant.

Other economies are approaching that, or if they exceed it substantially, they are exporters.

We have built up to a level where we have something like 10 tons of steel in use per person, many of the other metals of course in appropriate concentration, or quantities.

Now, the development process taking place elsewhere in the world at a rate which is rather slow on a per capita basis, but nevertheless, which is significant from the point of view of the demands which are being placed upon what you would call "insulated, accessible, relatively easily accessible raw materials." I suspect very much when you consider the explosive economy of Japan, where she must import virtually everything she uses in the way of raw material, you look at the expanding economy of Europe, both east and west, and you look at the increasing demands in the developing countries, the competition for the accessible resources are going to become ferocious, and I expect are going to become ferocious in the next 30 years. You might say, and I would say that from a purely technological point of view one can, just, if necessary, off an ordinary rock, as we know—at the same time it costs more to do it that way—and as a result of the fact that it does cost more, you are always going to try to do the easier things first, and as a result the competition, just like they exist today in a world of iron ore, and petroleum, are going to become increasingly ferocious I suspect, with respect to raw materials generally.

I would like to add to that another very important element. Just look at the quantities of these materials that are necessary. That is, were the world, as a whole, with a population of about 6 billion, and I don't think it is going to stop there, to be brought up to the levels of consumption of the United States and Western Europe today, it would require quantities of ores, which would be produced today by all of our mines and all of our factories working 400 years, it is in that order of magnitude, which you would say is a very, very substantial amount of stuff to move, and indeed would make man a major geological force—a greater geologic force than he is today, but then I would like to add on to that the fact that not only in my opinion are these competitions going to increase, but the unhappiness with the satisfaction within the developing countries themselves, concerning their slow rate of progress, on a per capita basis, can well produce an explosive situation which from a purely technological point of view might be an advantage, but from a political point of view, they might not really be problems which can be handled. In other words, I suspect, just as civilizations have declined in the past, it is quite conceivable that we are on the edge of a new and major decline today.

Mr. KAHN. Let me make another comment on that. First, in terms of the actual demand for raw materials in the next 10, 20, or 30 years, there is no study shown in the charts. Resources for the future are studied intensively, people looking for shortages, they can't find it, and they can't find it for good reasons. In some ways they go down. In general, I would say that as these resources deplete, the improved technology for substitution, for finding more, for using more, is going up faster. Now, I don't know what happens if you try to make the whole world simultaneously postindustrial, I think that would be folly, but that is because this is the law of compound interest.

When it comes to the issue of the undeveloped world, I think you have it sort of half-right, in that you may well pose ourselves unsolvable problems, and using the ensuing guilt in such a way as to really hurt ourselves.

I have a friend in mind who once wrote a speech on Latin America for President Johnson. The first draft said we must set ourselves to eliminate the economic gap between Latin America and the United

States. That is impossible. That would destroy two-thirds of the United States. Nothing in Latin America can do it, you understand. He tore that up. The second version was to dedicate ourselves to have the gap decreased. He had to tear that up. We must dedicate ourselves to not increasing the gap. That is very hard. It is nearly impossible. He had to tear that up. He finally came up with a formulation. Dedicate ourselves to decreasing the rate at which the gap increases. That is a feasible program. But does anybody here want to storm the barricades for it—a goal like that?—no? It is a self-defeating program which reduces people to semantic poverty. Latin America is close to $400 per capita. If India can do what Latin America did, in the next 30 years, it is an unbelievable accomplishment. Yet we must say that they went from 109 total poverty to total poverty. Let me finish this point.

A program for which I would be willing to storm a barricade is to triple the gross output of Latin America in the next century. It is very impressive—triple.

We must triple the GNP per capita. That can be done. But we better get started now. It is tough.

Now, let me ask some people, how many of the people in this room have felt deprived? Let me define desperate poverty for you. Any man with 20 percent of your income is desperately poor. But by Rockefeller's standards, you people live poor, deprived, squalid lives. You don't notice it because you think you are rich.

I would thus say that you don't want to make gap theories. They condemn people to semantic poverty. They condemn them, no matter how much they succeed, to failure.

And the realities have nothing to do with the way the people concerned think. The poor peasant worries about his older brother, the guy sitting next to him, how his father lived. It is perfectly possible to go to Latin America and say nobody can make you rich in 10 years, but by your living standards, we can make you rich in 30.

Let's get to work. But the heart was taken out of these people because we insisted in comparing them with the Americans instead of comparing them with their own situation and possibilities.

Let me add something else to this. About 3 years ago I got on a platform and said as far as I can see there will not be worldwide starvation in the mid-seventies. We better be alert to this situation. Now, if any man gets up and says there will be 100 million people dying of starvation, he seems wise, if he seems wise, if he says a billion he looks unbelievably wise. I got up and said, it is almost certain that there will not be worldwide food starvation or food deficit. In fact we can look for an agricultural surplus.

I don't know of a single major rice importing country today that will not become a major rice exporter in the mid-seventies. But a lot of people are investing hard-earned money in the food problem. They are misallocating effort, misallocating issues. I think it is very important in looking at these issues to take as accurate a look as you can, you know, to take the issues which really count.

Now, I myself refuse to worry about two important—so-called important issues. One, the increasing gap between the rich and the poor, north and south. It is going to exist as far as I can see. Probably two or three centuries will solve it because of levelling off of the postindustrial culture. Maybe not. But to me it is not the central problem of the 20th century.

Second, the population growth is an important problem, that keeps people poor, overcrowded and so on, but if you ask what really causes the problem, it is affluence. Rich men buy more and make more garbage than poor men, taking up an unbelievable amount of resources and space.

I don't know what to do. You know, what I say was in terms of garbage caused by technology, and that is the basic contradiction. I think we can fix it, but I do not believe the population explosion itself is the central issue. It is the richness of people more than their numbers that causes poverty. By the way, this is not to remark that population growth is not important.

It is not the top priority, that is why it did not appear in the chart.

Dr. Bell. Dr. Whipple.

Dr. Whipple. I want to comment on the question of depletion of raw materials, and particularly the problem of power, I mean physical power irks, that it is often brought up in these arguments. I take the opposite side I think from Harrison Brown, because I recall so well, when I was a boy, my father said that when he was a boy his father kept worrying about the fact that the whales were being extinguished and there wouldn't be enough tallow for candles.

This problem of raw materials and resources, I think that was solved very quickly by the technologies developing, and the fact you go to the slag heaps, and the slumps, for sources of material, and there is no real problem there, because your technology has improved so much. No mention has been made of the power problem here, specifically.

Again, I remember all through my life, there has been the story of the oil depletion and during that time, checking approximately every 10 years, the number of proven oil reserves has kept increasing. This can't go on forever, but there is shale, and so forth, for oil. But the real point of it is that we have a new method, a new source of fuel, namely, the fusion process, which I am sure is going to come in within your 30 years, become a practical method, whereby the gram of seawater will be worth in energy about a ton of coal.

So I do not believe that any pointing of disaster, because of lack of materials, or because of lack of power, is going to enter into this whole problem.

I do wonder, though, in this country—for the Congress—why it is that we think it is so important to develop our own reserves if we are worried about the number, the lack of oil in the future. Shouldn't we entirely import oil and save ours for the emergency, if that were really a problem? But that is an aside on the whole problem.

I don't believe that can be a factor in it. The lack of materials or the lack of power.

Dr. Bell. Dr. Tribus, you had a question.

Dr. Tribus. Listening to the scenarios, I was reminded of something Irving Langer used to say, that there were convergent and divergent phenomena. Divergent phenomena are those which have an inherent unpredictability, and convergent phenomena are those we are used to in physics. We know what will happen almost independent of how the thing starts or independent of small pertinent ovations, and for

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divergent, he would use the example of the physicist that stopped after work to look at the cosmic ray trace, and therefore arrived at the intersection in time to be run over by a truck. In a certain sense that cosmic ray event caused his death.

Now, there are a number of minor changes that one could make at various points in the scenario, that led to rather different results.

Let me just suggest one, because it is one that I have seen.

We spoke of the child who might have to be weaned from the computer, because of the way the computer had been programed. But my own studies and work with youngsters, my own, and the computer, has taught me that what we want to do with these machines is to turn them into being taught machines, rather than teaching machines—machines that respond to the child's creativity, and which the child must teach, rather than learn from. There is possibly, also, a relationship between man and computer, in which the computer behaves to the man in much the manner of the servants that we could have available in this country say just after the Russian Revolution, when royalty had to come over here and work as servants. Very well educated thoughtful people who tried to do what you wanted. And that kind of relationship between man and the computer is possible, and minor changes in the way we are developing that relationship can lead to that.

That changes man's relationship to the machines, his thinking power, it changes many things, and I suggest that these are also in the offing, and therefore the views that we have of what lies out ahead, you know, might not all be so ghastly.

Dr. Bell. Congressman Fulton.

Mr. Fulton. I have a different view on this. The people of the world are very pedestrian. We are peasant minded because we think of only the surface of the earth. As a matter of fact, we discovered in the moon a new continent one-sixth the size of the earth, with all its assets. We aren't even talking about doing anything with it.

To me, the earth is a source of material, not as a place to travel, on a surface of water or earth. That is one of our troubles. We are surface bound, like peasants, all of these thoughts of how to climb a field, climb a hill, or climb a mountain. We don't know how to extrapolate the world.

I look at the world in about 100 years as being a stable body that can't afford oceans. Nobody will ever see the sun in my view, because whatever water there is we will keep on top of 10,000 stories, at either 100,000 or 125,000 feet.

Dr. Whipple, of course, has been one of my teachers on astronomy. The cowboys of the future, instead of herding cows, will be riding rockets, rounding up asteroids of pure metal, in the asteroid belt, 50,000 of them, between Mars and Jupiter. We have all these materials lying around us, and we aren't even talking about them. And so I would say you scientists of the world—you scientists as we say in Pittsburgh—are rather pedestrian in your thinking.

The trouble with us in America—and I hope our foreign visitors don't take this too seriously—is that we often turn into do-gooders. We want to do good for our fellow citizens, whether they want it or not. The trouble with America is, she's perhaps turning into a minor scourge. They used to duck people like that in the good old Boston days. In New England, if you got to be a scold, telling everybody what to do, they took you out, man or woman, put you on the end of a pole and ducked you. Maybe that is what is wrong with the United States. I said to Dr. Whipple at lunch that good astronomers haven't gotten to the point—I think it was Dr. Van Allen, too—of trying to remake everybody. At a certain point people don't want to be remade.

Your science doesn't have that obligation.

So for me, I may like it just like it is. I don't want to be remade. And I want my freedom. And I want to decide, not you, even though it is good for me. Do you agree, Mr. Kahn?

Mr. **Kahn**. I would say yes, but I have one problem. If the pace is allowed to rip uncontrolled, I don't think either of us will like it. It may look like you described, 20 stories away from a meadow, 50 stories away from a pond. I don't think people really like that.

In other words, you take away people's freedom in the world you just described, where nobody has the right to walk down the path or take a swim in a pond.

Mr. **Fulton**. Between babies and walking down a path I never heard the combination. I think we may have to sacrifice the peasant idea of walking down a path in the moonlight, because we will probably have a series of moons with Dr. Van Allen and Dr. Whipple telling us how to evaluate them, so that we don't disturb the ides.

Mr. **Kahn**. Yes. What I don't like about my whole talk, and by the way what I don't like about my whole study, is that we started out being technocrats, liking technology, and the do-gooders weren't too much of our problem. And we ended up with Harrison Brown.

I tried to emphasize as much as possible the difference between me and Harrison.

Mr. **Fulton**. I just think you are not raising your sights high enough——

Mr. **Kahn**. Psychologically.

Mr. **Fulton**. When we start talking about the peasant idea, and stop keeping our balance on peasant's feet in science.

Mr. **Kahn**. You are not going to use the moon in the next 30 years in my judgment, for any technological advancement, 50 or 100 years, sure we may.

Mr. **Fulton**. We found we can grow beans better on the moon soil than on the earth.

Mr. **Kahn**. I believe that. You really are in position where a prolific mind becomes appropriate. This is one point where you have a special responsibility to understate the apocalypse, if possible, without understanding the issues. But the apocalyptic mind is appropriate.

Mr. **Fulton**. My point is, Do not reduce the number of people, but create greater assets.

Mr. **Kahn**. I believe the following is correct. You know how to get a piece of food per acre, so you have that formula. We now know pretty well how to increase food production per acre. The arithmetical argument that food will not be produced is sort of dead. I'm ready to believe we could support on this planet unbelievable numbers of human beings in reasonable health, and train them in reasonable happiness, so they will fit into it.

I'm also prepared to believe, however, one should make major efforts to slow down the long-term population growth. I also believe it is likely to slow itself down without any effort.

That is, almost all long-term population predictions tend to be off, and in a country like the United States, I rather suspect the very rich will have a lot of children, more than they do now.

Mr. Fulton. We are not all Kennedys and Rockefellers.

Mr. Kahn. Yes, but they are the very rich. The poor tend to follow the habits as the middle class, sexual habits, the upper-middle class, so I suspect the U.S. population is ironing out. In fact, we see a definite decrease in our estimates for the United States.

For the rest of the world it seems to me serious population limitation problems are in order. I think they have not first order of priority, but I would not like to be seen in the record as against it. I really think you want to look at the thing.

Dr. Bell. We want to get to Professor Beer's papers. We will take a 5-minute break, but no more than that. I suggest you don't go too far outside the room.

(Short recess.)

Dr. Bell. The second paper we have is by our guest from England, Stafford Beer, called "Managing Modern Complexity." It is a paper available previously, distributed in advance.

Those of you who have had a chance to read it will realize it is an austere paper, and to some extent may give you fear this will be highly abstract.

I do not know Professor Beer, other than by his works, so I can tell you if you read his works, even though he has written a very austere paper, I expect he has the soul of a poet.

Simply because the epigraph of his book "Decision and Control" begins with a phrase from Shakespeare which says, "From woman's eyes his doctrine derives, they sparkle still the light prometean fire."

Any man who can begin a book on management science with women's eyes, and dedicate it to Synthia, I suspect must be his sparkling promethean fire, his wife, is a man that is not at all austere. So I have high hopes for Prof. Stafford Beer. [Applause and laughter.]

STATEMENT OF PROF. STAFFORD BEER, DEVELOPMENT DIRECTOR, INTERNATIONAL PUBLISHING CORP., AND VISITING PROFESSOR OF CYBERNETICS IN THE BUSINESSS SCHOOL OF MANCHESTER UNIVERSITY, GREAT BRITAIN

Professor Beer. Thank you very much.

Mr. Chairman, Congressmen, ladies, and gentlemen. I do esteem it a great honor as an Englishman to be here today to talk to you, although I think it may be a little less than hospitable of me to follow the performance of Mr. Kahn. [Laughter.]

However, I was thinking of turning to the subject of managing information.

It has been mentioned we have a background of governable crisis, and I don't think we can ignore that. There seems to me to be two major methods by which one can tackle problems of this kind. One is to make forecasts, and there is another, they are not mutually incompatible or exclusive, and this is to try and uncover the inexorable trends in society which will lead us wherever we are going.

The very start of all this I suggest to you is complexity. The elements of our society is more likely indirect, the more this happens, the more the streams of data flow, the more complex this society becomes. Handling this complexity, as a fabric, seems to be the major problem of our age, in the way of handling material substances was a challenge to our forefathers. Computers are the tools we have to use, and their use must be directed by science, competent to handle the organization of large, complex, probablistic systems.

This, I believe to be the science of cybernetics, as first defined in America, not so much as the term is used in America today. It is the science of communication control.

The central thesis might be expressed by this that there are natural laws governing the behavior of large interactive systems, in the flesh, in the metal, in the social and economic fabric. These laws have to do with self-regulation and self-organization.

They constitute the management principle by which systems grow and are stable, learn and adjust, adapt and evolve. These seemingly diverse systems are one, in cybernetic eyes, because they manifest viable behavior—which is to say behavior conducive to survival.

In my opinion, the most important fact which a quarter of a century's worth of cybernetics has revealed is that this behavior is governed by the dynamic structure of the system, rather than by special events occurring within it or by the particular values taken up by even its major variables. Structure means the way in which the parts of a whole are interrelated; and here it includes both the feedback loops by which systems regulate themselves and also the conditional probability mechanisms by which systems learn and organize themselves. "Dynamic" relates to the speeds at which communication is effected within the system, and especially to the relative lags with which messages are promulgated, overtake each other, and combine to form new patterns. Dynamic structure generates outcomes.

Therefore I say that what will happen to mankind in its battle with complexity will be determined neither by particular innovation nor by isolated achievement at some unknown future date. Hence the attempted prediction of such things is not to the point. Outcomes are latent in the dynamic structure of the systems we have or may adopt: they will inexorably emerge.

At present, the most obtrusive outcome of the system we have is a gross instability of institutional relationships and of the economy. This cannot last. The society we have known will either collapse, or it will be overthrown. In either case a new kind of society will emerge, with new modes of control; and the risk is that it will be a society which no one actually chose, and which we probably will not like. I shall argue that we must use our science to detect the latent outcomes which will one day characterize the future of mankind. And let us so engineer our systems that their latent outcomes suit our social purpose. It is true that the outcomes cannot be fully determined, because there is noise (or shall we call it free will?) in the system. But a systemic design taking due account of cybernetic laws may be expected to produce behavior which is predictable in terms of the overriding social need for stability.

Thanks to the growth of complexity, which is very much a function of the growth in data-handling capacity and of the information explosion, society has outgrown the dynamic regulating capacity of its own hallowed structure.

History did not design that structure to cope with such complexity, and a cybernetically grotesque machinery is a result. It is from this standpoint that I ask you to look again at the environmental crises from which our view of the future must necessarily start.

The thermonuclear threat is a computable threat, and one which computably grows—although we act as if we were inured to it. The various pollution threats—by pesticides, by noise, by sewage, by carciogenic urban air—were and remain systematically predictable. None of these things happened by chance, by accident, or by the wrath of God.

We have run ourselves into these problems by failing to calculate the predictable consequences of the systems civilization has underwritten. The same seems to me to be true, though less obviously so, of the various forms of societary crisis which run alongside the environmental crises.

Problems of race, problems of poverty, problems of overpopulation: all these are quantifiable aspects of computable systems. It has taken social upheaval and threatening violence to draw them to our proper attention; it has taken a major revolt of the young to motivate any kind of rethinking.

The risk which faces us today is the probability that society will yet refuse to study the systemic generators of human doom, and will disregard the cybernetic capability which already exists competent to bring these many but interrelated forms of crisis under governance.

There are two reasons for this fear. First of all, our culture does not take kindly to the notion that it nurtures the seeds of its own destruction. Instead of studying the system in reality in which outcomes are latent, it prefers the technique of prognostication. Small wonder: by using such wholly nonsystemic devices as the Delphi technique, we may predict a possible millennium for our comfort. But the Delphi technique is aptly named: its pronouncements are shrouded in ambiguity—because they take no account of the systemic context. Meanwhile, the systems we have already started, which we nourish and foster, are grinding society to powder.

It might sound macabre to suggest that computers will finish the job of turning this planet into a paradise after human life has been extinguished. But that vision is little more macabre than the situation we already have, when we sit in the comfort of affluent homes and cause satellites to transmit to us live pictures of children starving to death and human beings being blown to pieces.

The second reason I have for my pessimism is that technology now seems to be leading humanity by the nose. We appear to have no sense of priorities where our problems are concerned; we do what is technologically easy—and we do it regardless of cost.

For example, the problem people have of transporting themselves from one remote place to another really exists between homes or offices and international airports. But the problem we continuously solve is the nonexistent problem of moving between those airports.

It is easier to go from mach 1 to mach 2 than to tackle the genuine problem. Perhaps it was also easier to go to the moon than to face up to what is happening in the street outside.

Thus I direct myself and you to the claim that cybernation is about the regulation of society, and that this is what computers are for. Perhaps this opening is a surprise. Would it not have been easier for all of us to plunge into the technology of computation, to prattle on happily about nanoseconds and massive data banks, to wonder at the explosion of knowledge and the impending marvels of data storage and retrieval by holograms and photochromic tubes, rather than to tell the truth about cybernation? What did you really expect? The fact is that most of the problems we stand ready to consider are bogus problems. They are generated by theories about technological progress, and theories about the way society works. Theory is often the only reality countenanced by our culture.

The reality is that we are elements in a vast and almost ungovernable social system generating outcomes that happen to us. We come sprightly to conference, dragging lead-heavy bones, to talk about machines that matter only if they can help us men. Our fat is suffused with insecticide, but we are avid to decide what it will be like to take our newspaper out of the back of the television set. The expansion of knowledge will yet save the world, shall I not tell you, coughing through the carcinogens—and assuming that my plane was not hijacked and that I was not mugged on the way.

I am fighting for a way through to your real ears. That is exactly to say that I am trying to differentiate, in you, between data and information. Data are a whole lot of meaningful patterns. We can generate data indefinitely; we can exchange data forever; we can store data, retrieve data, and file them away. All this is great fun, maybe useful, maybe lucrative. But we have to ask why. The purpose is regulation. And that means translating data into information. Information is what changes us. My purpose too is to effect change—to impart information, not data.

Data, I want to say to you, are an excrescence. Data are the very latest kind of pollution. We are not going to do anything at all about the management of information and knowledge towards the regulation of society at long as we think in data-processing terms. That is technologically easy. It is what the computer companies and the telecommunication interests would like us to do. Data are assuredly the great new marketable commodities of the 1970's. But, let me repeat, data of themselves have no value.

What has value is the machinery to transform data into information, and the machinery by which that information may be used to innervate society. Society has become a complex organism, and it needs a nervous system. Managing the development of informational science and technology is all about this task. There is no other message than this.

In my written paper I have set down at some length the bases of my arguments.

And I have put together four rather heavily considered propositions of which only the first is really the crucial one. Do listen to it: We can now automate whatever we can exactly specify.

Second proposition: Most (possibly all) ostensibly human prerogatives for inferential, judgmental, learned and adaptive behavior can be exactly specified—at least with respect to finite contexts.

To extend the second proposition to intuitional and creative behavior poses grave difficulties of definition, and invariably invites emotional uproar. But we may at least stand by this weaker statement.

Third proposition: Within specified frameworks, much ostensibly intuitional and creative human behavior can be indistinguishably imitated by machine.

Fourth proposition: Distance is technically irrelevant.

All this means that purposive systems can now be created to undertake any kind of purpose at all. We know how to design those systems, and how to innervate them with data streams. And so society would appear to be confronted by a problem of choice: what activities should actually be automated? But I shall argue that this question is largely illusory.

First of all, there is the logical trap. This is the sort called by logicians a fallacy of addition. We may do any of the things we can do; it does not follow that we may do all the things we can do. In the present state of the art, that is to say, we shall rapidly exhaust our reserves of skill. So here is the proviso about technological capability. My own belief is that we shall have to embody a great deal of basic software in special purpose hardware, and that we shall need to automate the creation of special software itself. I think that computer science will break through the barrier of human programing, and move to an era when programs are writen by machines under general human surveillance. This will in turn lead to programs which modify themselves in the light of experience. Then we shall be near the realization of the machine more intelligent than its designer, which Von Neumann envisaged and showed mathematically possible more than 20 years ago. There is no need for more than this one paragraph of such modest guesswork—because after that it may well be too late to do what ought to be done right now. At any rate, this is the only technological barrier which I can identify.

Then we revert to the spurious problem of choice. Why should not responsible authorities choose between desirable and undesirable systems for handling knowledge and information? The answer is that in neither the private nor the public sector of a free society is there a sufficient concentration of power to do so. If, for example, mammoth publishing interests decide (as they may) not to mobilize the resources of electronics adequately in the dissemination of knowledge, then it is open to electronic interests to become the publishers of the future. It is also open to the information handling community itself to embark on entrepreneurial activity at the expense of both these industries. In the public sector, it is certainly open to central government, through its grant-awarding agencies in particular, to encourage or discourage particular applications of cybernation. But it will be very difficult to inhibit developments which are of themselves economically viable in the way that (for example) space exploration would be inhibited without central funding.

And here we perhaps identify the basic nature of the problem which cybernetic systems set out to solve. Throughout history until this time the problem was to acquire sufficient information to generate effective change. The individual wishing to become expert in some field of knowledge had to buy information expensively; the Government wishing to understand even the rudiments of the structure of its society had to buy information through the census. And so we have gone on, paying more and more money for data acquisition—on the assumption that data constitute information. But we have already said that data becomes information only at the point when we ourselves are changed. It is self-evident that our capacity to be changed, whether we are an individual seeking private knowledge or a government seeking understanding of society, is strictly finite. In conditions of data paucity, almost all data acquired can be transformed into information—and used to procure effective change. But in conditions when the supply of data far outruns this metabolic capability, most data are literally worthless. Yet we pay more and more for these worthless data because that is the established order of things.

The fact is that quite recently the sign of the information problem changed from plus to minus. The problem is no longer about acquiring data, which are generated as a byproduct of every modern undertaking. The problem is about informational overload. The private citizen seeking knowledge is inundated by information which is virtually free. Yet the publishing industry responds in the old mode—by selling him yet more. The firm continues to buy expensive market research, because that is what it has always done, oblivious to the fact that transactions of every kind can now be electronically monitored, so that data are in glut. Its problem too is one of procuring adaptive behavior, and no longer at all one of "finding the facts". As for government, there is really no dearth of societary information either; there is instead a problem of organizing information—across departmental boundaries and in time.

Institutions, firms and (thanks to television) private citizens today receive critical information very quickly indeed; the aggregate picture at Federal level is slow by comparison to materialize. To put the point the other way around, then, the body politic has wildly overactive reflexes. In the body physiologic this is the condition of clonus—it is a symptom of spasticity. If we live, as I suspect, in a spastic society, it is because of clonic response. And by the expectations of these arguments, the clonus will get worse.

Thus I argue that the problem of information management is now a problem of filtering and refining a massive overload—for all of us, whether citizens, firms, institutions, or governments. We might well say that it is a problem not so much of data acquisition as of right storage; not so much of storage, as of fast retrieval; not so much of retrieval as of proper selection; not so much of selection as of identifying wants; not so much of knowing wants as of recognizing needs—and the needs are precisely the requirements of systematic equilibria.

This almost tabular account of the matter ostensively defines another cybernetic truth. In any controlled system, there must be an hierarchic array of subsystems, in which both the values and the structure of any one subsystem are set by a logical superior system. That is to say that one cannot discuss the purposive nature of a system in its own language, but only in a higher order language. There are potent reasons for this in theoretical logic, just as there are potent practical issues in terms of the need systematically to reduce the informational overload by a system of filters. These filters are necessarily arranged hierarchically, in a way which matches the hierarchy of logical systems.

Thus I introduce the concept of metasystem; a system which stands over and beyond a logically inferior system and one which is competent to handle that lower system's logic. Please note that metasystems are logically superior, and not necessarily more senior or more highly endowed with status or privilege. Please note also that in an hierarchy of systems there will be several orders of "meta." Let us take a moment of time to illustrate these points, since the concept of metasystem plays an important role in what I have to say.

Consider for example a school, in which each of a hundred teachers adequately controls and instructs a roomful of pupils. The roomful is in each case made up of several sets of pupils. Now each set of pupils is in fact pursuing a course of instruction which takes it from one room, one association of sets, and one teacher, to another room, another set of sets, and another teacher. If we consider the totality of rooms, holding their pupils and teachers, as subsystem of the school (for this is indeed the organizational format we observe on a visit) there is no way of knowing or discussing in such terms the educative process as it affects all the pupils. To do this we shall need to find the metasystem which organizes all the groupings and insures that they mesh together. This metasystem is the timetable, in terms of which the course followed by a particular pupil stands revealed. This is a logically superior system; but we do not expect the teacher in his room to treat the timetable as some kind of ju-ju. On the contrary; but if he wishes the timetable altered, he will perforce raise the issue in metasystemic terms. It is simply no good to say "this is my class, and I will take it at another time."

Furthermore, if the State wished to discuss the total process of education for all its high schools in relation to nursery schooling on the one hand and to university education on the other, then a new metasystem would be required. And in this case the question whether the second metasystem is not only logically but also constitutionally superior would arise. It would be discussed in those familiar terms about autonomy, about professional integrity, about bureaucratic interference, about suboptimization, about synergy * * *. Such discussions would be less boring if we could get the logic right first.

Let us now retrieve the argument that the development of purposive automated systems involves a spurious problem of choice. For, we argued, there is no method in a free society whereby such choice could be implemented. I would like to examine this argument in more detail, with a view to uncovering certain mechanisms which are germane to the issue before us. The objective now is to try, like good scientists, to determine the basic parameter of the problem at some level of abstraction which facilitates understanding. Were we to fail in this endeavour to stand back and to generalize, we should conclude with long lists of possible systems, in hundreds of possible contexts, with long lists of possible dangers attaching to each. Then we should achieve no useful insight at all.

Firstly, what is the entity which will in practice develop systems of knowledge and information? It is some kind of social institution: perhaps a firm, perhaps a profession, perhaps a social service * * *. Whatever it is, it is surely an identifiable entity, with certain recognizable characteristics. I call it an esoteric box. What is going on inside this box is an established order of things: things accepted as mores of the box, things professional, things historical, and so on. There is a complex arrangement of subsystems, a strange set of relationships between people of standing inside the box, and a recondite way of behaving. These features—their complexity and unintelligibility to the outsider—justify the box's adjective "esoteric." Admission to the box's activity cannot be gained without the appropriate passport. But the box is not a closed system, it is part of society; it certainly has inputs and outputs. Even so it is internally and autonomously self-organizing and self-regulating. And although the box processes whatever it exists to affect (and this is often people), that which is processed does not change the box at all. The box goes on; it is very powerfully organized to maintain its own internal stability, and therefore its survival as an integral institution.

I have elsewhere sought to show that the esoteric box, the identifiable social institution, is a strongly robust system in equilibrium. If we try to influence its behavior by changing variables which apparently affect it, it responds neither by collapsing nor by a violent reaction. It simply shifts the internal position of equilibrium very slightly, thereby offsetting the environmental change that has occurred. (In the model from physical chemistry that I have used to study these boxes, this behavior would be an instance of the operation of Le Chatelier's principle.)

Now it is an esoteric box which is going to develop an information system directed to cybernetic ends, its primary objective will be to enhance its own performance and chance of survival—it will not attend first to the performance and survival of society at large. Equally, the box will be highly resistant to efforts made to constrain its freedom to do so. There seem to be only two mechanisms available to a free society seeking to influence an autonomous institution in any case. The first is to facilitate some modes of development and to inhibit others by the provision of incentives and inhibitors from outside. I mean by this the awarding or withholding of grants, tax concessions, public campaigns, and so on. Every esoteric box has its own feedback mechanisms; what the State can do is to change the gain on the relevant amplifiers. But because of the high internal stability of the box, we must expect this kind of control device to operate in a cumbersome and generally inefficient way. The other device available is legislative. The main trouble here lies in the identification of what is antisocial. Most advances in human welfare have paid a price in the infringement of personal liberty; whether that price is seen as reasonable or as a fundamental deprivation of human rights will often be a matter of interpretation. But I shall in any case assume that wise government will interact with the authorities in any esoteric box to achieve acceptable codes of behavior. What really concerns us in this situation is what happens at the metasystemac level.

The fact is that esoteric boxes interact. Any major facet of public policy, such as health, education, the manipulation of credit, security, and balance of payments and so forth, involves at least a string and possibly a complex network of interacting esoteric boxes. Now just as the esoteric box itself is seen as something extremely stable and survival-worthy, so the system which links the boxes is typically tenuous and unstable. It is not itself an institution, not itself a higher order esoteric box. It is simply an assemblage of esoteric boxes, and it does not constitute a proper metasystem at all. It is in this fact that the threat to society really lies; it is here that we shall seek the important scientific generalizations.

Consider education, for example. There are, to speak arbitrarily, four major esoteric boxes involved in this facet of society. There is the system of compulsory schooling; there is the university system; there is the postexperience career-oriented system sponsored by industry; there is the free market in adult education. All four of these esoteric boxes may be subdivided, almost endlessly; but we are seeking to move our thoughts in the opposite direction—to identify the commonality of these systems and to examine their interactions. If we take health as our example, we shall find a similar situation. There is an esoteric box labeled general medical practice, and another called hospitals; there is a public health box labeled sanitation; there is a market-oriented box dealing in pharmaceuticals; there is a marketplace for medical information which belongs to publishing.

In short, we may take any facet of social policy and find the strings and networks of highly stable esoteric boxes which between them make a composite but not integrated impact on the individual citizen. We may do this for security, discovering esoteric boxes for the police, esoteric boxes for fire protection, and esoteric boxes for insurance—not to mention the esoteric boxes which are the armed services themselves. We may do the same thing for the movement of goods, discovering esoteric boxes for every method of transport. We may do it for the movement of money, detecting esoteric boxes for emolument and social benefit, for taxation, for credit * * *.

Then the question arises, why are those strings and networks as unstable as they appear to be? If there is no genuine metasystem, why has one not grown up? Was there never a stabilizing structure of any kind? I think that there was a metasystemic structure of a very remarkable kind, but that it has been abandoned. We have thereby lost the metacontrols which made the composite system of esoteric boxes viable. If this be true, no wonder we need assiduously to design replacements.

First, there was the structure of society's "external skeleton": the religious, legal and moral framework. Into this hooked the structure of the "internal skeleton": there were indeed formal bonds linking social institutions themselves. Younger people seem to be systematically abandoning the values of the external system, so that it ceases to be relevant to any control process dependent on negative feedback. Given that almost 50 percent of the population of the United States is now under 25 years of age, the revolt of youth is destroying metasystems whose stabilizing value they do not understand is a serious matter indeed. The young have more power in society than ever before; purchasing power, and the power that derives from not being afraid of inherited norms. Most of them are not taking technology for granted. Many of them are questioning established values in terms which their elders do not understand. Some have already begun smashing up computer installations. As to the internal system, changes in technology are moving the interfaces between the esoteric boxes representing established institutions—and they are not responding. Instead of evolving by adaption, these boxes are putting up the shutters and seeking to maintain themselves as integral systems while the context changes around them. This will not work.

Thus the strings and networks are unstable, and the metasystems are missing. Rather than attempt the exhaustive enumeration of these composite systems let us try to state the features they share in terms of knowledge, information and control. They seem to me to be the following:

2. CHARACTERISTICS OF STRINGS AND NETWORKS OF ESOTERIC BOXES

(i) In all cases some esoteric boxes in the system are part of the public sector and some part of the private sector.

(ii) In all cases the esoteric boxes are generating, and (inefficiently) passing between themselves, knowledge about the the world in which they operate.

(iii) In all cases they are also generating, either as primary or as spinoff data, knowledge about the individual citizen which they rarely interchange.

(iv) In all cases the very forces which produce stability within the esoteric boxes themselves, conduce to instability between the boxes.

(v) In all cases, what constitutes the improved management of knowledge within the esoteric box has to do with the rapid matching of sets of possible courses to sets of actual conditions, and the rapid correction of mismatches by feedback governors.

(vi) In all cases what would count as an improvement in the management of information between esoteric boxes, and therefore an embodiment of the metasystem concerned, would be an integral information network and a mutual tradeoff in knowledge—both of the world and of the citizen.

If this list of six points correctly states the position, it behooves us to elucidate them further.

3. ELUCIDATION OF SYSTEMIC CHARACTERISTICS

We begin this elucidation by developing a generalization about the management of information within the esoteric box. This is an explanation of point (v) in the foregoing list.

Whatever we are looking at at any given moment in time will be found to represent a complex state of affairs. Call this total situation the initial condition. For example, a patient entering a health system has an initial condition; so has a pupil in any educational situation. The first step taken by a professional in reviewing this initial condition is to try and characterize it with a name. In the case of health, this name is the diagnosis (diabetis—"he needs more insulin than he has got"). In the case of the educational condition, we may name a state of ignorance relative to some need (advanced physics—"he needs more physics than he has got"). This naming process may be very inefficient, as for instance when we name the complicated economic status of a citizen within the economy as: credit—$100. And even in medical diagnosis, for instance in psychiatric medicine or in prophylactic medicine, the name may not be very much help. Then why do we go through the naming process?

The answer to this is surely that the brain is a coding device. We are not cerebrally organized to hold in our heads large wedges of information about complicated states of affairs. Having examined the complexity of the initial condition, we seek to encapsulate it in a name—which can later be used to retrieve at least the critical attributes of the situation so named. Next, we use this name in our search of courses of action from which to select a treatment of the initial condition. Thus the very mention of a medical diagnosis selects in the mind of the physician a subset of the whole set of human therapies which relates to the name, and from this subset one therapy will be selected and applied. Similarly, "advanced physics" selects a subset of courses from all possible education courses, and from that subset one course will be recommended. The credit rating simply selects one figure from a small number of possible figures to be applied as a ceiling on purchasing power.

Depending on the seriousness of the situation, as measured perhaps by its "professional" content, this naming filter is a more or less elaborate tool for making the system work. A higher professional content can be injected into the process by a more elaborate taxonomy of names, and also by iterating the process of selection. Thus, having made a diagnosis and selected a possible therapy, the physician will go back through the name filter to the actual initial condition, and verify the treatment in every particular. In most social situations, however, this iteration is far too expensive to undertake. And for that reason, many of the responses which social systems make to the initial condition are crude indeed.

The first general capability of automation within such a system is to abandon the naming filter. For computers can hold large wedges of information. The computer is faced with the problem of matching one complex profile (the initial condition) with another—probably less complex—profile of possible courses of action. Far from simply automating the human professional component in the system, then, the automatic system should much improve upon it, especially if it is organized to interrogate the subject in order to full out details of the initial condition which it perceives to be relevant.

Moreover, as its model of the system it handles is enriched and improved by experience, it becomes possible in principle for a preliminary choice of action to be iteratively simulated. Then the likely effects of choosing this action, and in particular the vulnerability of this strategy to unknown factors or a range of possible futures, may rapidly be estimated before any indication of choice is given at all. Next again, if the automated system is geared to invigilate the actual process of applying the course to the initial condition, so that the subject's response is continuously monitored, then corrective action against any mismatching or systemic oscillation may be continuously taken. And of cuorse, it will be taken on the basis of the total richness of possible interaction between the two sets (states of the subject and possible treatments) rather than through the exiguous filtering channels of the naming which have hitherto been used with so little finesse.

In all of this we find key applications of another fundamental cybernetic principle: Ashby's law of requisite variety. Variety is the cybernetic measure of complexity. It is explicitly the possible number of states of a system. The law says that the variety of a given situation can be managed adequately only by control mechanisms having at least as great a capacity to generate variety themselves. Names typically do not do this: they are archetypes of variety reducers. Indeed, in most socioeconomic situations of our age, we seek to obey Ashby's law by reducing the variety of the real world, necessarily in a somewhat artificial way, as with naming. As I said earlier, this leads us to manage low-variety theories about the economy, because we can handle those. rather than to manage the high-variety economy itself. A much more satisfactory method of handling the problem is to increase the variety of the system doing the judging, managing or controlling—by automating the professional component. The second method is not technologically open as we saw in the last section. Allied to the fast feedback, whether through simulations of the total system or through the invigilation of actual results, the whole mechanism permits a much more refined and much speedier convergence on a stable outcome.

By looking at this mechanism in its relevant detail, we simultaneously lay bare the major threat to privacy of which everyone who has ever contemplated these matters is already aware. As we seek better control of situations by confronting variety with variety within the system, we lose the anonymity which used to cloak the identity of an individual by the use of a name. This is quite clearly seen in the simplest case of all—the name of the citizen as normally understood. My name identifies me from among the rest of us here; but it undertakes to disclose no more information than this primary selection. Yet the more effectively any esoteric box handles my case, then the higher the variety it disposes as a measure of my own variety; therefore the more risky to my personal integrity does the whole process become. Here is the person rawly exposed, because in higher variety, within the professional system appropriate to any esoteric box. And I am saying that the better the system, both from the point of view of the social institution concerned and therefore from my own as its patient or pupil or client in any other way, ipso facto the more potentially damaging to me is that system. Am I psychologically ill? The medical systems will know. Am I educationally inadequate to my job? The educational system will know. Where was I at the time the murder was committed? The credit system knows when and where I bought petrol that night * * *.

This analysis successfully generalizes the problem of privacy, and also says a great deal about the reasons why esoteric boxes are under such pressure to withdraw into themselves—instead of collaborating in metasystemic management systems (see point (vi) in the list).

As to privacy: It is all too possible that the computer will sweep forward to destroy privacy and freedom of choice without our really knowing that this is happening—much as the motor car has swept forward, poisoning us and inexorably changing the quality of life. Consider two major mechanisms which might bring this about.

First, there is the question of a man's credibility as a citizen. When a man is too well documented, electronically buttoned-up, in what sense can he make a new start? How can he restore his credit, once it is lost? How will he persuade the machine to emulate his own God-given capability to forget? A man is to himself as to others a complex package of information. In behavioral terms at least, his vital statistics, his knowledge, his actions and his emotional response as well—all may be cataloged and stored. By the criteria of information theory, then, my electronic image in the machine may be more real than I am. It is rounded and retrievable. Above all, it is a high-variety image—higher very likely than the image of me in the minds of my own friends. The behavior of the image is predictable in statistical terms.

Probably I am not. But the strength of the machine image is its pragmatic validity. There is no confusion here, no ambiguity, no loss of history, no rationalization. I am a mess; and I don't know what to do. The machine knows better—in statistical terms. Thus is my reality less real than my mirror image in the store. That fact diminishes me.

Second of the threats to my reality, there is the likelihood of my manipulation on a scale which is also frightening. Overt advertising has already taken us to the brink of what seems to be tolerable in this respect. But at least we are conscious of the risk—we may note the Freudian images of the adman cult, and the importunity of slogans which are akin to physiological conditioning. We may thus protect our personalities. But the computer's machinations are covert. A long-term record of my purchases should enable a computer to devise a mailing shot at me which is virtually irresistible.

As to involution: We earlier made the assumption that esoteric boxes themselves will engage in dialog with their own clients and with governments to protect the citizen in this threatening situation. The important thing is not so much that this ought to happen as that it will certainly happen. For if it is vital to the social institution to remain integral, and if it is the proclivity of that esoteric box to be highly stable, then integrity and stability will be supported and reinforced by the highest ethical codes where professions are concerned, and by commercial self-interest where they are not. Each esoteric box will identify its own vested interest in solving these problems; and in solving them it will increase its own stability and survival power. Then these systems will become more involuted, and yet more esoteric; they will become more stable, and more resistant to change; in many cases it will be literally impossible to assess the information they contain without a special electronic key.

As the solutions begin to emerge from the studies which institutions are already making, it can be expected that legislative force will be asked for the implementation of any provisions which repeatedly occur as proposing matters of principle. For example, it already looks likely that legislation will be sought to permit the citizen access to his own computer files, or at least to permit him the knowledge that an entry has been made therein. Even so, there will be many difficulties for legislators, and especially difficulties of definition. After all, many records have been kept in the past, records made up with quill pens, of which the citizen had no intimate knowledge—and in cases of national security, or even of high-grade employment, perhaps no knowledge at all.

But the point for which we are reaching here really concerns the missing metasystems for the regulation and stabilization of strings and networks of esoteric boxes. If the inexorable trend is toward involution, and toward the isolation of information within the box, then the interchange of information between esoteric boxes becomes less and less likely (see point (iii) in the list). Institutions will not dare to move toward the creation of metasystems because this would breach confidentiality. As for the legislators, how can they possibly launch bills at one parliamentary sitting intending to keep information inside the box (for the reason adduced), and then launch bills at the next sitting aimed at better management on the strings-and-network level?

For the requirements of the second legislation would be to assemble information more economically for metasystemic purpose, to enrich the understanding of social needs by synthesizing information within higher order models of the economy, and in general to seek modes of control which would necessarily diminish participation at lower societary levels to the point of total incomprehension as to what was going on.

This is a king-size dilemma. It has already been encountered in a relatively mild form by government bureaus of statistics, all of whom operate under legislation which guarantees the privacy of the individual firm by statistical aggregation. But in situations where large firms dominate sparsely populated localities, real skill may be needed to avoid betrayal of this rule by sheer accident. And perhaps in avoiding such risk the efficacy of the network will be sensibly reduced. The extension of the problem down to the rights of the individual, and up to meta-metasystems, and across to include the whole gamut of socioeconomic behavior, is a daunting prospect. But the difficulty is real; it will not go away.

So here is the meaning of point (iv) in the list of characteristics we set out to elucidate. Strings and networks of esoteric boxes will become less and less cohesive; and the metasystems they represent will become more and more unstable. These are the inexorable trends, and this is the basic reason why (I unhappily suggest) society is falling apart.

The blurring of interfaces: We have been seeking to elucidate the meaning of the four final points of the six statements made in the list which ended section 2. It is time to revert to the first two of those six points. For in our recent discussion we have concerned ourselves primarily with information about the citizen as a product of either public or professional social institutions. But the argument of points (i) and (ii) was that every facet of social control shared in the public and private sector, shared too in knowledge of the world as well as in knowledge of the citizen. Then let us begin a fresh analysis, beginning with the missing pieces of the puzzle, and see where that leads.

We want to talk in the first place, then, about knowledge of the world, and its dissemination as an entrepreneurial activity to anyone needing knowledge. This whole process began and continued historically in a very distinctive way. There were people—individuals by name—in the time of the ancient Greeks in whom reposed such knowledge as there was. Those wishing to acquire knowledge did so on a personal basis and at great expense. This often meant journeying to sit at the feet of an Aristotle and to learn from him. We might call the process "custom-built publishing". We should note that it was a very high-variety process (the cybernetic analysis of a dialog demonstrates to perfection Ashby's law of requisite variety). And we should note finally that the effectiveness of the process relied on a relative paucity of knowledge compared with the capacity of the human brain and the calls on its time. For nearly 2,000 years this situation prevailed. Although writing and its tools were developed, any piece of writing was still custom built. One's copy of any text was a personal copy, bearing unique imperfections, omissions and additions. Then, 500 years ago, came printing—a process which remains almost unchanged to this day, as the accepted principle of permanent imaging.

It was the invention of printing that procured the first qualitative change in the management of information and knowledge for mankind. In achieving the massive dissemination of knowledge Gutenberg and Caxton also destroyed its custom-built character. In mitigation, the publishing industry (as it has become) developed an activity called editing. This critical occupation fulfills almost exactly the same function as naming or diagnosis in our earlier model. It constitutes a crossover point between a high-variety set of information on the one hand and a high-variety set of clients on the other; it selects subsets from each, and attempts to match them. Insofar as the matching succeeds, there is a marketable product. This may be defined as an edited publication, identifying a sufficient number of clients satisfied with the editorial process as between them to pay for the cost of publishing and printing (with of course a profit margin for all concerned).

The steady development of this whole marketing operation has led, like all other recent developments in the dissemination of human knowledge, to the informational overload mentioned before. Publishers continue to issue more and more printed material, relying specifically on their editorial skill in identifying market subsets willing to pay the price. But increasingly the process depends on mythology. It is easy enough to demonstrate that in fact the overload threshold has already been passed, and that (as we said) the sign has now changed on the stream of data input. No professional man can possibly read more than a fraction of what he would like to read or feels he should read. In some professions, current trends when extrapolated show that the whole population of professionals will shortly be employed in preparing abstracts of papers—whereupon no authors will be left to write them. This shows that insofar as people continue to purchase new publications they are not driven to do so by any residual capacity to convert data into information (meaning: what changes us). One may entertain various theories about the motives which do drive them. Such theories range from feelings of guilt and a sense of threat at one end of the spectrum to a pious belief that the editing process is (hopefully) converging on my special interests at the other. However this may be, no professional man can now cope effectively with the material he is expected to buy; and most would agree that they buy more than they can cope with.

Various mechanisms may operate to put an end to this situation, perhaps quite suddenly and dramatically. Which mechanisms will operate depends on which motives turn out to be most significant. For example, insofar as many publications depend on their advertising revenue for survival, then when the advertisers become aware that their advertisements are not even seen (because the journals are not opened) they may suddenly and disastrously withdraw support en masse. But the more profound threat to the established mores of the whole industry derives from the likelihood that someone will give convincing entrepreneurial effect to the unrecognized but inexorable trends of the situation. These are quite simply that professional people have a need for less and not more information, and therefore—in the long run—are going to pay for less and less, and to refuse to pay for more and more. The publishing industry and Government itself continue to regard data as equivalent to information. The metasystem in which this issue can alone be sensibly contemplated, will shortly recognize that any one client is overloaded by any one editor who provides for the needs of a coterie, however small, intended to cover his costs.

There is then an inexorable requirement for a return to custom-built publishing directed at individuals, whether private citizens or cabinet ministers. This service must be economically viable, once the necessity for it is generally recognized, because it meets a need which cannot much longer be ignored. Moreover, the new technology is able to supply it. We shall use the power of computers to undertake an editing process on behalf of the only editor who any longer counts—the client himself. It matters not whether the information reaches that client on a computer terminal, or in a custom-built personalized print. Economics and personal preference will decide that issue. What does matter is the inevitable reversion to the age-old principle of publishing based on the finite capacity of the brain to assimilate data, and to convert them to the information which changes the brain's condition. And in all of this we may note the mechanisms already uncovered in this paper; especially obedience to the law of requisite variety, and the vitality of the principle of adaptive feedback.

I here repeat that this kind of prognosis is not to my mind a matter of forecasting, but the detection of an inexorable requirement. There is no need to extend the argument to publication in the field of leisure, important though this is, because the considerations are much more difficult—and I think longer term. But the field of professional publishing, which includes knowledge about the whole of science and technology, and includes knowledge about everything that Government may do, is sufficiently significant in itself. Both areas may be treated as their own esoteric boxes. In both cases there has to be a high variety of *exposure of the client to the system*, and there has to be fast adaptive feedback. If you will allow that this is possible, then we reach a new dimension of concern in the field of socioeconomic management.

We know by now, as a matter of principle, that the increased effectiveness of the service provided inside an esoteric box increases the vulnerability of its clients to intimate relevations—because of Ashby's law. The case of both commercial and governmental publishing to professional individuals offers no exception. In exactly the same degree, and be exactly the same mechanisms, that custom-built publishing becomes effective at all, so does the increasingly well-served client become a target of exploitation. Insofar, that is, as a particular product of either commercial or governmental publishing is especially meant for me, valuable to me, valued by me * * *. So far is it irresistible to me. We encountered this point before.

There is no problem here so long as we continue to speak of professional publishing by reputable publishers (and governments) itself. The matter for concern is of course that if such a system works for this purpose it will work for other and nefarious purposes, too. If we can encode an individual's interest and susceptibilities on the basis of feedback which he supplies, if we can converge on a model of the individual of higher variety than the model he has of himself, then we have exactly the situation inside the automated system which was observed to be such a threat in more protected contexts. I think that marketing people will come to use this technique to increase the relatively tiny response to a mailing shot which exists today to a response in the order of 90 percent. All this is to say that the conditioning loop exercised upon the individual will be closed. Then we have provided a perfect physiological system for the marketing of anything we like—not then just genuine knowledge, but perhaps "political truth" or "the inelectable necessity to act against the elected government." Here indeed is a serious threat to society.

Now we can see how the first three points in the "List of Characteristics" about the behavior of esoteric boxes are indivisible from the the last three points. Knowledge of the world and knowledge of the citizen are indissolubly united in systems of the kind we must expect; private and public interest moreover are inseparably involved in each. Then the interfaces between these four major components of information systems become hopelessly blurred. We shall not be able to legislate to keep what is indivisible divided. These arguments are based on realities manifested by situations which cannot be controlled at their own level without interference on a totalitarian scale in the rights and autonomy of our social institutions, the esoteric boxes.

4. METASYSTEM MANAGEMENT

The jigsaw puzzle is complete. We have looked closely at the emergent picture of interacting social institutions, exemplified as esoteric boxes. They are stable, involuted, resistant to change. Their interaction is embodied in strings and networks of complex connectivity, exemplified as metasystems. There are unstable, mercurial, existing more in concept than reality. The problems of information management that assail the boxes will be solved, if with the greatest difficulty. These solutions will themselves inexorably increase the metasystemic instability, threatening to blow society apart.

If all this offers an effective generalization of the problem of data pollution, and if we are to see any possibility of its solution in terms of good cybernetics, practice is needed in applying the model here envisaged. Let us then look at two levels of application, as widely separated as possible, to see how readily the systems concerned map onto each other, and what may be the commonalities of acceptable metasystemic controls.

First example: at hearth and home

One plausible development of existing capabilities in informational science looks like this.

It is already possible to transmit textual material and the instructions for printing it into a television receiver—during a normal broadcast, and without interfering in any way with the broadcast itself. This is done by utilizing some of the enormous channel capacity available and not used by the flying spot defining the picture. For example, the spot has a "flyback" period, when it returns from the end of one scan to the beginning of the next. One line of scanning on a TV screen contains approximately 600 bits of information. The flyback takes five lines to return, and is thus capable of carrying 3,000 bits of information. If 60 frames are scanned every second (this would be 50 in Great Britain) there is spare capacity to transmit 180,000 bits a second of other information while the broadcast itself is going on.

We know how to produce hard copy from the television set, using this input information. If we wish to produce a column of print 6 inches wide, with excellent resolution at a hundred lines per inch, we need 600 by 100 bits of information to produce an inch of text. It follows from all this that we have a capacity to produce 3 inches of text every second without interfering with the television broadcast.

Newspapers can be produced in the home like this, as is well known, and experiments continue. But newspapers are not custom built; they belong to the informational overload. This overload is due to be met by custom-built publishing. Then apply the existing technology to the new publishing concept and see what happens.

Suppose that there are 20 buttons on the side of the television set which can be pressed by the viewer. The broadcaster invites the viewer to participate in a "personal response program." He shows the viewer two pictures, and asks him to press the first button if he prefers the first picture to the second—otherwise not. He then asks a question, and says that the second button should be pressed if the answer is yes—otherwise not. And so on. By the time the viewer has pressed or not pressed all 20 buttons he has identified himself in a high-variety way. For there are 2^{20} ways in which the set of buttons may be pressed, and that means enough patterns to distinguish between more than a million individuals (where each offers a separate pattern). As to privacy, the viewer is at home and alone with his set. So no one knows which buttons he presses (or do they?).

Having completed this exercise, the broadcaster suggests that the viewer should press his "print" button. The television set will then print out, from the vast amount of information being carried on the flyback, a piece of print which is determined by the particular pattern set on the 20 buttons. After all, if the sponsor hires 1 minute of flyback time at the end of his advertisement, he may transmit no less than a hundred and eighty inches of text. The computer program set up on the 20 buttons selects, say, 6 inches of this available text, and the apparatus prints it. This means that the individual concerned receives a very highly directed message. By the arguments used earlier, the viewer is likely to find this message irresistible. For example, the old lady sitting in one house reads "This product is especially suitable for old ladies," while the young man next door reads "This product is especially suitable for young men.". (One needs little knowledge of the advertising world to recognize this example as remarkably naive.) Moreover, because the TV set is in a particular location, and can be preprogramed with that information, the custom-built message and advertisement could well include instructions as to which local supplier will make what special reduction for immediate compliance with the suggestion to purchase. Again, this example is offered for display purposes only: the opportunities are hair raising. Suppose for instance that the apparatus is able to store previous sets of responses.

The viewer lifts the telephone in order to place his order—or perhaps he simply presses a new button on his set labeled "Yes." The supplier now has an order, and his system (for he is his own esoteric box) must immediately check the credit worthiness of the customer. If by this time we have reached the cashless society, it could well be that the whole transaction is finalized and the viewer's bank account debited within the millisecond.

This is all entertaining and something like it will very likely happen. Now consider the esoteric boxes on whose integrity and security he relies, but which he may by now himself have violated. The information he betrays might well include his medical status, his educational status, his intimate psychlogical situation, the family context (i.e., someone else's privacy is breached), the employment context (i.e., commercial security may be breached), the economy's view of his credit, the state of his bank balance, his religious outlook, his political outlook, his social attitudes at large * * *.

Twenty bits, a variety of a million, every time; here is an inexhaustible source of metasystemic information available to anyone who sets out to acquire it. And from this information could be synthesized a new account of society and of the economy, orders of magnitude more powerful and valuable and threatening than any we have hitherto known or countenanced. With this unthinking violation of privacy goes the betrayal of all of the mechanisms for protection and security to both the individual and the state which the esoteric boxes themselves have sought to guarantee. And with it go also the distinctions between public and private information, knowledge of the citizen, and knowledge of the world.

Second example: in world economics

Undertaking now the largest possible change in the scale of this thinking, and leaping over a staggering array of other plausible examples large and small, we turn to the future of mankind itself and the stability of world economics.

A consensus of opinion might define an economy as the observable, quantifiable aspect of the social metasystem. The metric of economics appears to offer the only lingua franca which enables us to talk in figures about strings and networks of esoteric boxes—for typically these have no other commensurable denominator. But it seems to me most important to observe that this circumstance has let us into jejune descriptions of the social weal—which are obsessionally treated as merely economic. Surely no one can believe that the total state of the world with all its pressures, ethnic, religious, lebensraum-oriented, power-geared, and all its problems of military, societary and environmental crisis, can adequately be discussed in terms of econometric models. Input-output analysis tells us something about the connectivity of esoteric boxes; cash flows say a little about their dynamic interrelationships; but we may discuss fiscal and monetary policy until we are purple without touching on the major causes of even economic disequilibria, still less of social dysfunction. This contention is relevant at both the national and the international level.

Having criticized the metric that is used and the models that are adopted, I may readily claim that the networks linking social institutions at this level are the most tenuous yet discussed. This underlines the fact that major political entities—states and nations—are the ultimately complete exemplifications of the esoteric box. They answer both to the definition of this term and to the behavioral analysis of its operation. I shall risk, as your foreign guest, a remark about this which I hope will not be regarded as a solecism. We have just entered the decade in which the founding bicentenary of a remarkable interactive network will be celebrated in your country, the metasystem for which is perfectly exemplified in a federal constitution and its law. Is it not fair to say that there are esoteric boxes within this system, some of which are whole states while others are social institutions of other kinds, which maintain to this day those characteristics of the integral, stable, change-resistant box which we have taken much trouble to elucidate? And if there is cause for alarm about national instability, then surely it is metasystemic in nature. Correctives are hard to apply, for reasons we have also uncovered; they lead to involution and even exacerbate the problems.

At the level of world affairs, the case is far more strong. The sovereign nation is the ultimately esoteric box; the interconnective networks between nations are like so much spun silk. All the mechanisms described here clearly operate, and they too are clearly involutionary. The problems and threats are the same, but they are written large. Just as we may identify spurious metasystems purporting to link the esoteric boxes of our own social institutions, so there are spurious international metasystems. All approaches to world government, from the League of Nations onward, and including market-oriented consortia, speak metalinguistically but do not operate metasystemically. This is why I call them spurious. Hence it is in the network of world economies that we find the ultimately inadequate description and the ultimately incompetent management of the ultimately unstable metasystem.

Perhaps the nearest approach to genuinely stable organizations of this kind are the multinational companies. They represent linkages of esoteric boxes, beyond doubt; they certainly have identifiable metasystems. Even so, the cohesive forces required to make them survivalworthy, barely emerge—given a potentially hostile environment. Do we have adequate management mores and philosophy, company lore, or international law, to underwrite their responsible self-regulation? It is a serious question, bearing in mind that these companies are in a sense the emergent nations of the next few decades. I mean by this that the gross product of some mushrooming companies already exceeds the gross national product of the smaller historic nations—for whim, tradition, constitution, legal precedent, and other longstanding regulators provide the cybernetic grounds of stability.

The vision of a small but historic nation in revolt is bad enough. The explosion of knowledge among people whose intellectual horizons are thereby expended and burst, the extension of personal vulnerability and loss of security through the uncontrolled spread of informational networks, and the political threats let loose by all of this, could turn such revolt into a societary crisis for that national of unexampled magnitude. It would have to rely very heavily on the propensity to stability of the esoteric box to contain the situation. But what if instability such as this were to assail a multinational company of greater size than this nation, a company that is not itself truly an esoteric box but a network existing at the metasystemic level without a metasystem. This would be a leviathan greatly to be feared, a leviathan obscenely polluted by its own data which it found itself powerless to metabolize.

5. OUTCOMES FOR ACTION

Action is required. The form of this action is a matter for you rather than for me. My endeavor has been to penetrate the immense complexity of the information management problem, in search of a scientific generalization. This I have tried to define in fairly plain English, to describe and to exemplify. The objective was to aid your endeavor to decide right action.

I suggested before that the problem is to manage complexity itself, complexity considered as the very stuff and substance of modern society. In the end, when all the computers have crunched their numbers to the last intransigent bit, the unquenched spirit of man takes final responsibility for life or death. Even so, this spirit necessarily operates—for ordinary folk and Senators alike—through the medium of the human brain. This is one computer among many larger and faster—if so far less flexible—computers.

The crebral computer is no more than a 3-pound electrochemical device, slightly alkaline, which runs 10,000 million logical elements on the power of glucose at 25 watts. Its ability to discriminate is somewhat less than people imagine when they think of the human being in mystical terms as suffused by the divine afflatus. We can in general discriminate on a variety scale of about nine. To understand in an average is our metier. If we then judge that something is slightly, considerably, much or hugely better or worse than the mean, we have done as much discriminatory computing as we can normally manage. That scale of nine points is an output of roughly 3.2 bits of information, only.

Improvement in requisite variety is possible, since we enrich the dimensions of our comprehension by interrelating several scales of discrimination. Even so, our human capability is geared at this general level. So when data processing systems offer us millions of bits of data, we dare not believe in a mythical metabolic process which would convert these data into information within our personal ken. There are inelectable limits to the assimiliation of knowledge, set by the finite size of the sugar furnace in our heads. These facts to my mind determine the sorts of action which count as both feasible and effective. I have refined my ideas about this to offer a final set of specific postulates.

1. We may, reasonably, assume that estoteric boxes can take care of themselves, since that is what they are for.

2. They can be aided; their actions can be facilitated or inhibited by government. Any intervention, however, interferes with autonomy, denies participtation, and may prove ineffectual—by Le Chatelier's principle.

3. Then legislation directed into particular boxes is unlikely to be much help. In any case, there is probably no time to tackle the problem at this level.

4. Then the focus of attention should always be at metasystemic level. This is the locale of societary instability; here then reside the massive threats.

5. First, the relevant metasystem must be identified, and in some sense institutionalized. Otherwise, who is to act or who can be held accountable? This primary task can be undertaken only by those holding the constitutional mandate.

6. The purpose of a metasystemic social institution is precisely, and only, to embody the nerve-center for metasystemic affairs. Its function is precisely, and only, to identify situations of dangerous and therefore explosive instability, and to identify trajectories leading to stability.

7. The recommended methodology is the construction of metamodels, continuously innervated by data effectively filtered through a cybernetically designed hierarchy of systems.

8. The implementation of conclusions might be vested in the metasystemic social institution; if it is, however, there will be problems about autonomy (see 2).

9. Insofar as legislation may be needed, the need can be pinpointed by these means. Directing either legislation or central executive action at strings and networks in the absence of metamodels is likely to increase instability rather than reduce it.

10. The kinds of model needed operate necessarily at a high level of abstraction; this makes almost everyone impatient. Consciously identify, then, the barrier to progress as anti-intellectualism.

Some metasystemtic institutions already exist. The World Health Organization and the Food and Agriculture Organization are examples at international level, as are several international economic bodies; Government departments handling whole sets of esoteric boxes are examples at national level. The questions I leave with you are these: Have such institutions been correctely identified? Do they at all map onto the dynamic structure of viable systems as understood by cybneretics? What other such institutions would be required in a stable society?

As to the warning in point 10 about anti-intellectualism, it seems that the arguments used here would themselves predict this self-defeating syndrome in a society newly faced with the need to manage overwhelming complexity. If the brain is eclipsed in terms of variety by the computer milieu, it may itself revolt. Then panic-stricken attempts at the highest and most responsible level to quell forces that are not understood are as dangerous as the irresponsible cavorting of hooligans.

One may already detect at either end of the scale of social responsibility a response equivalent to laying about with the jawbone of an ass.

The alternative is to design a stable society, and to treat our complexity control capability through computers as offering a nervous system for the body politic. This involves the deployment of a political science to new ends, in the recognition that our difficulties have gone beyond anything that can be grasped by a slogan. We should recognize a cybernetic issue for what it is. But when the unthinkable is already happening it is indeed difficult to think about, and we are robbed of our semantic strength.

Thank you very much.

Dr. Bell. Thank you very much, Professor Beer.

I must say in all the years I have gone to meetings, I have rarely heard a paper which is as packed as this and raises so many complex issues.

I should tell you Professor Beer paid me an extraordinarily high compliment in one other respect. He set the scale of information on the level of 9. There is a rather extraordinary paper by someone known by George Miller, talking about the magic number 7, minus 2, in which he places the scale at 7, which is something off of 9.

Here we are at the top number of 9, so we are really scraping the ceiling here at the top of our discrimination.

I would like to raise, or come back, however, if I may, to take the prerogatives of the Chair, to raise one or two questions about the language in the assumptions here, because some of the language, I suspect, grates against what might be called the populous mentality of Americans, or even the anti-intellectual tendencies of some Americans, not so much in the crude and vulgar sense, but when you use phrases like "laws governing the systems of behavior, that the system is more important perhaps than the events governing the change," it raises the question whether the framework is not too tight in this regard.

If one looks at the American society, one finds very few highly organized systems. One of the problems, perhaps, is we have too few systems. If you think of the health system of this country as a system there is no system at all. It doesn't hold together in any respect. There are no parts that can mesh in any way. One of the difficulties is the failure of this to act as a system, in these terms.

So perhaps in one respect you are far ahead of the frontier for the United States in this regard, but it raises in another way a different kind of question, however, which may, I say, is an inceptual question, namely, are you actually describing an ongoing reality, or are you perhaps imposing a logical order on them?

William James used to say the world is double-storing, there is a disturbing flux of moving and bustling noise and confusion, and the fact that the analyst that imposes a logical order on it, gets confused, perhaps, by the logical order, and imposes it back, perhaps on the society, rather than to let it try to work out some of the problems in its own way.

I raise this question. I can give one more analogy. There was once a mathematician trying to work out the best arrangement to get potatoes in a sack. He measured all the interphases of the shape of a potato, and measured all the topological curvatures to see which would have the best fit. He worked out some equation. He got all the 100 potatoes in the sack in a certain way, and then a peasant came along and gave it a little shake, the sack of potatoes, shook up a little bit, and the potatoes arranged themselves against one another.

You have a notion of how social change takes place. It doesn't always come from the pure logical, rigorous, interposition of the analysts on the outside working on all the complexities of the system, but perhaps a little more loose in the way in which it operates. I start out in one sense, perhaps it is too loose in the system and complain on the other sense you are a little too rigorous.

Professor Beer. You have, indeed, sir, I think in respect, you answered your own question.

I am not trying to make any prescription to society, and I am not trying to do anything other than suggest a generalized model which works at any level of society, whether you take this Japanese information on the overload, or the Government.

The guy with the sack of potatoes is the kind of scientist I am. I do not think that life is long enough for the kind of analytical approach which is normally the prerogative of the operational research man. I am looking for models wherein you can take bits of system, which are recognized, such as the bits of service, which you will admit is recognized, isn't pharmaceutically recognized, and shake them together and ask what is the stability of the overall thing.

I can speak a bit about Britain. There, in Britain, the bits is beautifully done, but God help you if you are a patient.

(Applause and laughter.)

Dr. BELL. This is not a private argument, of course, it is open.

Dr. Dupree.

Dr. DUPREE. Yes; I would like to ask: I am left somewhat unclear when I think of the institution, the university, and I am not quite sure whether it is an isoteric box or a mess system. I would be glad to have you comment on it?

Professor BEER. I think we are at the same level. This is purely subjective judgment, sir. The university is made up of a lot of isoteric boxes, and very esoterically, it can be. The question is, whether we have at all a government system in the university. I very much doubt it. This is exactly the problem to which I am drawing your attention, and I am grateful for your response to it.

There are spurious methods, and while the bold meet to try to determine how the university should be behaving, the faculty is a hard meeting——

[Laughter.]

Mr. GOLAND. I would like to say a word or two in support of the line of argument that you, Dr. Bell, began.

First of all, you will notice I have carefully refrained from saying anything at the conclusion of Mr. Kahn's talk, because discussing his talk reminds me of the kind of thing you say in Texas, it puts you in between a rock and a hard place.

If you are right, he will overwhelm you by his personality, and if you are wrong, he will certainly devastate you by his knowledge.

But I think that perhaps in Professor Beer's case, I can say one or two things. It seems to me that really, this type of an approach, which holds the promise of great rationale, is actually, if I may use the known term, anti-intellectual—well, let's go back into the history of physics.

At one time, in something as simple as physics—and I say simple, because as compared with social systems, I think we will agree even the most sophisticated physics is simple.

At one time there was a great argument in favor of the terminus, about rounding the terminus. This subsequently was discarded on the basis that in principle, a system may become so complex that it is unknowable. No less a person for example than Mac Born, in one of his books, concludes with the point that much I say about the box, is that a time history of amplitude, is it a series of harmonic sequences? In fact, it is none of these things. Something so far beyond us that in his words, and this is a fairly accurate paraphrase, that rationale in discussing that type of question is irrelevant, it has no relevance.

Now, I would raise the point that obviously rational systems must be sought after. They have a certain potential. But when we even talk about them, on the grand scale that Professor Beer has phrased here, we are really reviving a dead issue of determinants.

There are limits beyond which we can not and should not expect help. And I think it is particularly irrelevant in this particular audience, because ultimately we use an indefinable quality known as judgment, which needs no further justification in deciding many significant issues, and usually those issues are social and political.

So I would raise that point with you.

Professor **Beer**. Well, sir, I am a little bit lost. I have heard about rational conduct in many quarters but I don't expect it from this table. I don't understand you, really.

In England, we are able to produce, and I expect you are here, too, bogus things, which I defy you to recognize from the real thing, and you know, I don't accept the theories laid down. I specifically deny they have anything to do whatever with the old argument "We are dealing in a real world," and we attempt to model that world, and insofar as we succeed we survive.

Insofar as we fail, and pretend it is the way it is, we shall go down. This is my view. If you disagree with it, sir, I hope there is an agreement.

Dr. **Bell**. Does anybody else want to get into this argument? [Laughter.]

Dr. **Zucrow**. When you look at this from a simple standpoint, which is that of an engineer——

Voice. I object to that.

Dr. **Zucrow**. I happen to be an engineer. This is a real, complicated application of systems analysis to a very complicated system.

Now, when you do get such a system you first make up the best system you can think of, and then you should have some data, someplace—I don't know how much of this you can do from the sociological problem, but you play with the system with some mentalities, to see if you get the same type of result.

It may not be correct, numerically, you may say "Yes, if I do this, this will go up. But if I do this, this will go down." And you find that if you keep modifying your system, providing you do have information that you can quantify to put into the system, you get closer and closer to the real thing.

Now, I can even envision that you could do this with many things, especially with things that are well organized. But where you come into things like stepfunctions, you see, which can happen in any, you know, human endeavor, here I am a little worried, as to how far can you project what will happen unless you know what a stepfunction will do on this system.

And is there, or are there enough data on enough parallel systems from which you can make what I call educated judgments of whether the stepfunctions that you put in typify something that you have known in the past and the results that came out in the past?

Professor **Beer**. Yes, I am very much with you, in your comments, sir.

I think this is indeed the problem, but I think we are making very good progress in achieving what you have asked for.

One doesn't dream up a model in one's bedroom, and then leap to a computer and say that is how it is, follows. One either acts with the system, a model is much more about trying to assist the vulnerability of the strategists to unknown futures, than about saying, this is what will happen. Nobody knows that, in my view.

In the course of making experiments about vulnerability, the scientist and the manager, or the scientist and the minister, as the case may be, have got to work together in exploring the very areas which you have well defined. What does happen, if you put a stepfunction in the system? We can find out, of course.

One of the things that bothers me is on the one hand you have managers who will refuse to play this game at all, on the grounds that they are irrational, and by God everybody else better be irrational, too. And on the other hand you have some kinds of managers for that matter, saying the kind of models we need are immensely expensive and complex, and probably not doable at all, whereas to me, in the middle, if you have, on an annular computer, an organization with, let's say, 50 variables in it, and the right kind of lags in the feedback circuits, you are already far eclipsing the capacity of the human brain to understand what the hell is happening.

This is good stuff, and it ought to be supported, and this is my message, you see.

Dr. **Zucrow**. I agree with you.

Professor **Beer**. I am sure you do.

Dr. **Zucrow**. I was wondering—for example, in England, they built some new towns.

Now, you can get some information by studying something you know something about, you see.

Now, how do you take this from something like exists, which has not been modeled, and how do you set up that model?

Take the model of the ghetto and how it would be influenced by some social law and so forth and so on.

Now, it looks to me like in this area we have to devise a ghetto and divide the ghetto into a lot of subsystems—I don't see how they interrelate. And study things that have happened. And unless this sort of thing is done, it will always be done by human judgment off the cuff, see, and with a capacity that is limited, as you show, as to that information.

Professor **Beer**. Yes, I agree with that.

Of course, you need some data. You can't just make this stuff up. And before you can model a ghetto situation, somebody has got to talk to people in ghettos and perhaps little of that is being done.

I know about only one thing in America that bears on this, and this is in Philadelphia, where there is a lot of interaction going on and a lot of attempts by the University of Pennsylvania to understand the ghetto. The minute that data comes in, I am saying to you we can begin to model it.

Dr. **Bell**. Dr. Green.

Dr. **Green**. I am extremely interested in this exchange, I am not sure that I clearly see what the issues are.

But let me try, and respond to some of the things that occurred to me as I listened to it.

I think one of the most interesting areas to me in which we used the term "system" is when we speak of the educational system. I only want to call it to your attention, because in this country if one wishes to examine the use of that term, wherein by comparison to any of its employments in systems theories totally inapplicable, the educational system would be a good example.

There is a very real sense in which it isn't a system, and yet everybody knows that particularly if you examine it in higher education, you can go from university to university, you can identify the character of many of the structures, even the architecture, as being relatively standard.

I can take people to visit the spot where I am normally at home and show them certain buildings and they can identify immediately that is graduate student housing, and over here is the biological laboratory, and these are domitories, and so on. But not only that, there is also a standardization of procedure. There are standard ideology about it, involved. There is no describable system and yet—in a political sense—yet there is in a formative, kind of homogeneity. The description, just the barest description of that complex set of organizations which we glibly refer to as the educational system doesn't exist. There is, in fact, not even an adequate description of that system in the United States.

For this is one of those very large, complex macrosystems, you might refer to for which there isn't an intuitive account that can be given. And yet obviously, there are systemic elements, otherwise you can't account for the fact that a fifth grade class in a town in Kansas who is very much like one in certain regions in Washington, et cetera, how does that happen?

Now, I think I am not saying we couldn't describe something of that sort, nor that we couldn't describe components of it, nor, in fact, we couldn't model. I am saying I am not holding my breath waiting for someone to produce the adequate model that is going to describe, even the decision procedures within a loose confederation of universities in this country.

But, suppose we could? If we could develop the kind of model with extraordinary complexities, and if we could, therefore, identify how changes in one sector of it would affect changes in other sectors, would we want to do it? Would we want to employ that kind of insight?

I think the answer is clearly yes, we would. And then I think the question raised is, should we? I am reminded of a study which we undertook, which is currently in progress at Syracuse. It deals with an attempt to examine the relationship between the dispersal of Federal funds into school districts in the United States under title I of the Elementary and Secondary Education Act to see if we couldn't identify exactly how those funds reach their target and in what form and allocation.

The results are pretty well known, pretty well publicized. The question it raises is: What kind of tax, what sort of an understanding would you need in management of the system to make sure those funds reach the target that the Congress intended they should reach, as we said today, they should reach.

Then, one begins to imagine what would the system look like, and you develop a very rational, systemic way of doing it. Then one says, well, you know, if we had a real, thorough understanding of that kind of system, would we want to employ it to make sure funds would get where they are targeted. I think the answer is yes. And then the question we would want to ask is, would that leave us with the same political structure? Would it leave us with indeed the same quality that we have in this country, or policy we have in this country?

I think the answer to that is very problematic. I am only suggesting that in a way, the notion of system, that has been used in Professor

Beer's paper, also seems to me to be a kind of metaphor. It is kind of a metaphor, and has extraordinary limitations to it.

I am not at all frightened by the implications of what he says—not in the least.

I do not mean to imply to the term in any sense, the best distribution, as I said, for the following reasons: I used to tell my students at the university, I could assure them if they felt only at home, as they are strongly inclined to do from time to time, it would be—they could be absolutely sure I would not answer the telephone. And the reason for that is, whenever the telephone rings in our house, it is never for me anyway, and so I would have to call somebody else. They can be absolutely sure I will not answer the telephone.

Now, on that information, you know exactly what I will do, but I assure you it has absolutely nothing to do with their power or anybody else's power to control what will happen. I am only trying to point out that such a proposition under a predicted statement of the sort we know what will happen in a given system when a particular action is taken upon it or within it, does not imply at all that we can or do make it happen.

The values of the metaphor, it seems to me, is rather in its utility for what Mr. Bundy was talking about earlier this morning. It gives us some clues. To give us some clues for perhaps a more rational management, but it also, hopefully, will bring home to us the limitations upon which any rational management can proceed and still preserve the same kind of social institutions that we have at least the traditional thought was important.

Professor **Beer**. I would like to respond to that very much, though I feel that I really have a rather disadvantage because of the impression of my material, which was rather not impressive, I apologize for this.

First of all, I would personally deny we are talking in any sense about a metaphor. Science, after all, is about increasing abstraction of truth from various bits of reality to various generalizations working across reality.

We do not prove gravity in metaphor, simply because it is an abstract statement. We expect glasses to shatter if we drop them on the floor.

The laws I am trying to invoke in my paper, I believe, are at this time—I might be wrong—okay. But if I didn't believe it, and assert it as loudly as I can, I should then be a charlatan, because that is what my work is about.

The second thing I would like to say is I was very sympathetic with your question, except insofar as you seem to see education as a macrosystem, consistent with cases which could be studies as microsystems.

Now, please, this is the point of my address. If we compound small pieces of microsystems into macrosystems, we shall be stopped, and I believe we have an enormous complexity in cost. The point I am trying to make is that the education system at large is a metasystem, system, either being of schools, universities, and all the other bits, which are themselves esoteric boxes which work very hard. The fact those boxes work very well should be encouraged not discouraged.

But we cannot simply afford to let the thing go on. You say, would we want to and should we if we could, build that metasystem? There are two reasons why we must.

The first is that of friction between esoteric boxes in a changing technological media, being such that the very last person who will get considered is the patient or the pupil or the product that goes through a system of esoteric boxes. You cannot afford to educate pupils in junior school, then high school, then university, then in postexperential work, if these parts did not exist for him as a continuous experience. This is where we are wasting an enormous amount of effort to my mind, and doing a bad job, for that man.

That is the first reason for doing it. The second reason for doing it is, of course, just the plain cost. Because of the friction which exists between esoteric boxes which, I think, I can demonstrate by giving a model to you, the State has to use an oiling can to avert the friction between the boxes, and this is always monitored, it is always appropriations, it is always research, special inside boxes, in other words, grants, to try and overcome the restrictions.

Now, my point is, if we can make a metaphor, then we have a chance of looking after the citizen and a chance of doing this at a rather cheap price.

Dr. **Bell**. Dr. Whipple?

Dr. **Whipple**. As a human being, and as a scientist, I want to take umbrage with one of Professor Beer's earlier statements about data, his scorn for data, if I take him out of context.

I don't believe he means it, but he did use the term "expressants."

Now, as a human being, I have an information system that brings in, or can bring in, something like 100 million bits per second. I cannot possibly use that much information. I have to discard practically all of it, and so I discard—I use one millionth of it, perhaps.

And I would be very unhappy, knowing the capability I have, to receive information, to have this cut down seriously. If my vision goes up, my color sense is lost, I will lose a great deal. So esthetically, this is extremely important to have at my command 100 million bits per second even if I only use one-millionth of it. And as a scientist, of course, the same story holds, that the little bits of integration that we have made from our bits of knowledge, to generalities, have come in from absolutely excessive information bits.

If you think of Darwin, the Beagle, on the Galapagos Islands, and the generalities that came from his observations, you realize those pieces of data were available to many people that could make no use of them.

This integration of the mind, then, to make use of the data, is the important part. Certainly we cannot hope to make any progress in using computing machines and cybratronics, unless we have some method of integrating these and getting a cohesive generalization out of all the data.

But we must ask for all the data, and we must not complain about it. That is my point.

Professor **Beer**. Well, thank you, you put the point with great eloquence. I was right with you until the very last sentence. I complain, for one very special reason. Of course, I, as a semantician, use the human body as my paradigm the whole time. It is the amazing capacity of the brain to do this, and to reduce and reduce the mass of inputs, which is very impressive.

Now, my belief is that society, which is an intangible thing, has not got such a mechanism, and this is, of course, exactly what I am asking for. And I am sorry if I misled you by my attempt to be dramatic about it.

What I am saying is, if it is not enough to believe it, drawn from data, is going to do it, we have to have machinery which I believe is a logical complex machinery, rather than an authentic complexity machine, it is about logic. We need this machinery before we can do anything at all. I detect, or I think I detect all over the world, talk that suggests once we have generated enough data, once we have enough data banks, once we have this stuff all over the place, somehow our problems will magically resolve themselves. I know you wouldn't say that. This is what I was trying to make dramatic. We are short of the system to handle it, I am sure you agree from what you said.

Dr. WHIPPLE. In the earth sciences, and astronomy, the fact is we do collect a great many pieces of data without a clear knowledge of what we are going to do with them. But we find that they become extremely valuable in time, and the great catalogs in astronomy that have been accumulated with great efforts are used, and they are used day after day, and new results come out, and the computing machine helps the mind to focus on the generalities that are there.

I think the same thing will be true of social problems. You have not gotten to the state of putting the social data into the machine yet.

Professor BEER. Which is right?

Dr. WHIPPLE. Which must be done first. You cannot get it out unless you put it in first.

Dr. BELL. Congressman Symington?

Mr. SYMINGTON. You define a metasystem which is one over and beyond a logically impaired system and competent to handle a lower system's logic.

What I am wondering is, what is an individual man? He is what you defined as a subsystem or perhaps even lower than that. It takes more than one to be a system, certainly more than one to be an esoteric box, because only that can be an entity, like social institutions.

What I am curious to know is, man's logic being certainly lower than that of the metasystem is it possible the metasystems might eventually become discouraged at the amount of man's illogic that it has to account for? [Laughter.]

And attempt to effect changes in the man in order to accommodate him and take some of the strain off of the system in the metasystem? Whether this should be done genetically or not, it wouldn't be clear to me. I don't know whether to be alarmed by the prospective possibly. What would it do to our traditional concept of man and his character as we say, his personality, and so forth?

Can you enlighten me on your view of that, of man's relation to the metasystem, as you see it?

Professor BEER. Yes; I can try.

I think, if I may say so, that is a tremendously insight compliment. My belief is that the metasystems are there whether we like it or not, because society is something logically superior—logically superior to the individuality. Society does work as if the individual doesn't understand the needs of society. My whole point is we are numbered, as we say in England, we are caught with a spurious metasystem. It is there because it has to be there, but it doesn't work very well, and therefore it constitutes a pertinent threat. And if we let it run on, then

I think we should be in the kind of mess you are stating, which is wholly terrifying to me.

My plea, therefore, is that we should try and design the metasystem—and this has rarely been attempted—this is what my paper seeks to prove—the metasystems kind of get there, and when we don't like the way they work, we oil the wheels in the best way we can. We don't think of redesigning the thing properly. This is my thought that we should do so, but whatever criteria that political leaders can lay down as legitimate. Otherwise, I think—you know, I refuse to accept responsibility, for the systems are there and are grinding us to powder as I put in my paper. I just observed them, and I don't like it any more than you do. Let's redesign.

Dr. Bell. Dr. Malone?

Dr. Malone. Mr. Chairman, with a display of logic which was so dazzling it left me breathless, but slightly skeptical, Professor Beer brought us in the final pages of his paper to an option, to laying about with the jawbone of an ass-1, on the alternative as to design a stable society, and so on, and so on.

This morning you mentioned our postindustrial phase, and my question of Professor Beer is, could we have reached this postindustrial phase with all its grand opportunities, and all its horrible problems, if we had had the systematic stability to which you aspire? Obviously my question, I think not——

[Laughter.]

Professor Beer. Yes, "have you stopped beating your wife"? [Laughter.]

Mr. Malone. It is that kind of question, sir.

Professor Beer. Well, I would like to think in response to that, that semanticians are not complete yet, and learn something about the role of crisis and complex within systems. I think we do know a lot about this, and stability, you know, is to be achieved in very large systems, essentially, by balancing the forces of complexes, not by telling everybody what to do, because there isn't time, and we couldn't do it.

So I think we got where we are by the operation of the systematic approach in nature, laws in nature, if you have studied natural law. I think we could improve on it, if we did it self-consciously. Thank you very much, sir.

Mr. Bell. Mr. Kahn?

Mr. Kahn. I find myself impressed and appalled by my colleagues here in the university.

I spend my time in policy research. It is very important for me to have a sense of what problems can be done and cannot be done. As I move out from certain rather sophisticated military problems, into slightly complicated military problems, I find two types of things, and I find them much stronger in the social sciences we have today.

One, there is a lot of knowledge around which people do not use. There is an unbelievable amount of things that are done that are not done right.

Two, rarely little of these things are done, but not done, are in an academic purview. That group does not know these things. [Laughter.]

There are good reasons for it. They have leverage, these people in some sense, it would be done. Every paper I read in 1968 showed the long order was for anti-Negro. When the people reading the newspaper in half America didn't mean it that way. If you asked any taxi driver, it was automatic. They would say law and order was the biggest single problem they have, because they were the ones victims of crime, in the ghetto, so they worried about it. So I asked myself of the group of academic people that designed these things, what type of problems do they solve? I have noted every large model in the Pentagon has been a failure without exception as far as—you know, really big models—that is an impressive remark. Fifteen years now of this stuff.

Now, I have a hunch, I agree with Professor Beer when he says we should push this kind of thing. This is in some sense the wave of the future. But the wave of the future, whether 300 days from now or 3 days, I am not sure, but I think it is more like 300, for a lot of the problems you are trying to do here.

For example, I can look at a man's face and say he is puzzled, but I can't specify what made him do that. No man in the world can tell me that man is puzzled, and I don't know how to do it, or program it that way. It is a very simple thing, I solved the problem, you are puzzled, but I don't know the model. It has never been specified. It may be 100 years before we can do that. It is a little like the law of hydraulics and hydrodynamics. If I wanted to build something you went to hydraulics, if you wanted to discuss it in theory, you went to the hydrodynamicist. The field was different. They were put together, and suddenly hydrodynamics and hydro was one field, after electricity.

It will be a long time, like a decade. I might be wrong, please don't fasten me here, but I make a flat statement today there are very few complex computer models today.

Professor **Beer**. I have just a little to say about that.

I would like to make it clear, that I personally have never put a single model in a university. I worked with industry all my life, and that is what I am doing this summer. I want to pick up in your example, which I find is potentially dangerous. When you say he is puzzled, you are drawing a myth, data program, from the human face, the posture, the attitude, the thing that leads you to think he is puzzled. This is an immensely complex input. Second, you have had a great deal of experience in learning the model which classifies that as puzzled, haven't you?

Mr. **Kahn**. Yes.

Professor **Beer**. In society we have neither this vast input. We have a few indicators, such as the trade caps increases at this time. We have very, very little of competent experience, in recognizing the right word to lay on it, like puzzle.

I don't think this is really a bad example.

I think we are at a stage where, and I must repeat this, because this is the whole point I am trying to make—even a small increase in the complexity of the matter in which the brain can handle, large social issues, is very difficult. That is really what I am saying I don't think you would disagree.

Mr. **Kahn**. No.

Dr. **Bell**. Congressman Fulton.

Mr. **Fulton**. Professor Beer, if you are going to start building a system, you have to start with some sort of building block.

The question is, do you start with theory and logic, or do you start with man? Do you start with man? Do you start with him as he is? As he will be, or as he could be? And do you then, when you build this system, build in the assets, the liabilities, the defects, and these things that make man? You are talking about the instability of the system when possibly it is the instability of what you are working with.

Professor **Beer**. Yes, sir; I agree with that. To me I would say science is critical. I believe science has to start over, in observation, measurement, and experience.

Mr. **Fulton**. When you go to this system, you are going to have to take some sort of generic term, or an average, in order to get what you are going to need in order to make it generic.

Once you make a generic query, then, are you going to take the average man, the mode of a man that occurs, or are you going to take levels of intelligence? How can you make a system that would be so esoteric when you are dealing with such practical building blocks as man? Does your system theory hold up? Does it have a stable foundation?

Professor **Beer**. Well, obviously I hope so. I think that the people that first propounded the laws of gas panology were in the same problem, but you take the range of this behavior, seems to be a role that is useful, and it must be true in social situations.

Mr. **Fulton**. But does everyone sitting here have 3 trillion cells, and 60,000 miles of wires, veins, and capillaries? We have a system that in and of itself is not stable. Any bit of its consciousness is not a system, so you have a double arch instability before you even start. Then when you come to generalize, you put yourself into this system. Where does that bring us?

Professor **Beer**. Well, the model in physics holds again, doesn't it?

We had this with the principal tendency as a burden, and all that. I think the privilege of science is all over in kind, and we have to be optimistic about it, or we would never make any progress at all.

Dr. **Bell**. We have gone past the time which is at stake here. If I perhaps can try to sum up what I suspect is the difference that has emerged to some extent, there is the argument being made by Professor Beer of the possibility of what used to be called many years ago by Henry Adams social physics. It will not stop the argument which says you only have laws in physics when you deal with objects, and you can trace the pattern of the objects, and distinguish between the objects and subjects. In the capacity of objects, as subjects, you can redesign their world. They have subconsciousness being redesigning their world. Therefore, society is not purely something outside of man, because it is something in his head that can be designed. If it is inside his head, then it is not simply external fact, but men are able to think of society as a set of social arrangements. To have social arrangements, you can say if you have a metasystem not outside of men, but men operating, somehow win that, on the basis of values which they find better than others. I don't know if I am mediating the argument or further confusing it here, but I have tried to do so, at least with a spirit.

As Professor Cohen was giving a lecture, and somebody in the back said "Professor Cohen, how do I know you were there? He said, "Who is asking?" [Laughter.] [Applause.]

Dr. **Bell**. We will come back at 10 o'clock tomorrow and hear the papers of Professors Boorstin and Armer.

(Whereupon, at 5:17 p.m., the Panel was adjourned, to reconvene at 10 a.m., Wednesday, January 28, 1970.)

ELEVENTH MEETING WITH THE PANEL ON SCIENCE AND TECHNOLOGY

WEDNESDAY, JANUARY 28, 1970

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 10 a.m., pursuant to adjournment, in room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller, chairman of the committee, presiding.

Chairman Miller. The committee will be in order.

I again want to welcome you. It now becomes a great honor and personal privilege to introduce our keynote speaker for today, former Chief Justice of the U.S. Supreme Court, the Honorable Earl Warren. Governor Warren, I call him Governor because I had the privilege of serving under him when he was Governor of the State of California, and it seems more natural. He and I have been close friends for many, many years. We come from the same county in California. We served in public service in our home State. Despite our political persuasions, we are in complete agreement in our convictions with regard to the ideals of our Nation and our deep personal commitment toward achieving those ideals. I am sure that everyone in this room is aware of Chief Justice Warren's achievements. His career has been unique in scope and eminent in the progress of our time. I am sure that his wise and forceful counsel today will contribute greatly to the deliberations of the 11th meeting of the Panel on Science and Technology. On behalf of the members of the committee and myself, I wish to extend him my heartiest welcome to the meeting. I give you the Honorable Earl Warren, former Governor of the State of California, and former Chief Justice of the U.S. Supreme Court. Chief Justice Warren. [Applause.]

STATEMENT OF HON. EARL WARREN, FORMER CHIEF JUSTICE OF THE UNITED STATES

Mr. Warren. Mr. Chairman, members of the committee, distinguished ladies and gentlemen, this is great company that I find myself in today, and I am somewhat abashed at the role of being a keynoter for such a group. But it is a great privilege to participate in this conference, for the purpose of discussing the rapid expansion and use of knowledge brought about by modern technology. No one could have had my experience on the Supreme Court, in the last 16 years, without realizing the scientific and technological advances have brought vast changes in the life of the Nation, changes that carry with them implications of both good and evil, and which merit our most energetic consideration in gatherings of this kind.

However, until the passing of time compelled me to start thinking about what I would say on this occasion, in response to the invitation of my fellow councilman and long-time friend, Chairman George Miller, I never realized how audacious it was of me to assume that I had sufficient knowledge of these changes to justify my attempting to keynote a discussion by scientists, technologists, and scholars on the management of information and knowledge. Nor would I have been relieved of this anxiety by the fact that the particular subject on the day of my appearance would be the individual, the machine, and the State.

In addition to that, I was really shocked at my limitations in this field of knowledge a week ago when I read in the morning papers that a computerized and live nationally televised prizefight had been held the night before, between two former heavyweight champions, one of whom had been dead for many months, and the other was still alive. I was further amazed to learn that in theaters throughout the country, boxing fans had paid $5.50 for seats to witness it. But I was truly shocked when I read the live man was knocked out after 57 seconds in the 13th round.

But I wonder if that might not presage a new era throughout the world of sports. In baseball, why could they not abolish the draft and use as replacements Babe Ruth, Ty Cobb, and Christy Mathewson. And in football, Jim Thorpe, Red Grange, and Ernie Nevers. The games could be computerized before the season opens. Stadiums could be closed and even sold to save money, in this financial crisis, and everyone could see the game on closed circuit, in his comfortable livingroom or in an air-conditioned theater. And this means all the players on all the teams could be of championship caliber and their plays could be predicted by the machine to an absolute certainty.

Now, I do not know what implication such use of the machine would have upon the individual or the State, and I am sure it would be better for me not to speculate, because that is not the role of a judge. Traditionally, judges are not in the vanguard of any movement, nor are they supposed to survey the future to determine what should be done in the face of possible advances in science, technology, or human reactions to either. They are tied to the words of the Constitution, and words of the statutes, as they were meant at the time of enactment, and in addition to that, largely to interpretations of the past.

But this does not mean that courts should be or are impervious to change. They, like all of our discussions, must be oriented to the times and conditions under review. In this regard, I am reminded of the agonizing the courts have experienced in defining and applying the word "commerce" as it is used in the Constitution. That document states in simple language, and I quote: "Congress shall have the power to regulate commerce with foreign nations and among the several States and with the Indian tribes."

In the economy of those days, commerce was not a complicated activity, but was confined to traffic involving sailing vessels and animal-drawn vehicles. But, with the coming of the railroad, the telegraph, telephone, aircraft, radio, television, and electronics, the courts have agonized for 182 years to find an accommodation between such advances and the word "commerce." The end is now no more in sight than is the limit of scientific or technological development which is no more known to us than were the present day realities to Henry L. Ellsworth, the first Patent Commissioner, when he made his annual report to Congress on January 31, 1840.

His words seem strange to us now, but this is what he said in part. He spoke of the discovery of the electromagnetic telegraph, which he predicts, and I quote him now:

> Is destined to exercise a great and it is believed a happy effect in the transmission of intelligence from one section of the country to another. Experiments already made in England and on the continent leave no doubt of its practicability, and this will ere long be further tested on the railroad route between Washington and Baltimore.

He reports also, and I quote him again:

> The experiment of illuminating the streets of Paris by means of the electric spark, has, as communicated in the last scientific journals, been also most successful, and further development of this application of electricity may be expected.

He then sums up these startling revelations with the conclusions that, and I quote again:

> The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end.

He went still further, and intimated rather pointedly that in a period of a few years there might be no need either for him or the patent office.

Much of what has transpired since then is commonplace in today's world. Increased knowledge and its uses are advancing at an infinitely greater pace day by day. What will happen in the next 100 or even 50 years or less is little more in the comprehension of the average American than with our modern techniques in the vision of Commissioner Ellsworth.

Now, these advances cannot be stopped, and we should not try to stop them, even though some of them, as in the past, will be harbingers of evil as well as good. The job of every generation is to find an accommodation for them which will not dehumanize us or distort the ideals we have long held that have not yet been achieved for American life.

Today, in our traditional systems, both State and Federal, we have very serious problems which have more to do with the administration of the courts than with the interpretation of the law. Like business and industry, we, too, are paving the way for making use of electrical equipment to do much of the administrative work that has been done in the past by judges and their clerical staffs. The judges are presently overburdened with much paperwork of general administration, which is not germane to the judging process. Much of it can be done by machines, and through our new Federal judicial center we have made the studies to establish, for instance, the preparation of jury lists, the selection of jury panels, the summoning of jurors and the procedures for paying them can be done by a mechanical process with a minimum of both time and manpower. The bringing of cases to the trial stage and keeping the calendar in shape for more rapid disposition of cases can also be done with infinitely less manpower and far more effectively than it has been done in the past. Many hours of the judge's time can be saved by the use of computers, and the Congress has indicated such programs are desirable.

On the other hand, electronic equipment has caused the courts great concern because of the invasions of privacy. Electric wiretapping, which Mr. Justice Holmes of half century ago aptly described as dirty business, still plagues the courts. Also, today, there are even more modern and awesome electronics of sound and vision that invade the privacy of individuals in their homes and businesses and which unless adequately curbed in their use will cause grave dangers to our way of life. They have unlimited potentials for disturbing both individuals and business organizations. The right of privacy is one of the great values in life, and was well expressed by Mr. Justice Brandeis a half century ago in these words:

> The makers of our Constitution undertook to secure conditions favorable to the pursuit of happiness. They recognized the significance of man's spiritual nature, of his feelings, and of his intellect. They knew that only a part of the pain, pleasure, and satisfaction of life are to be found in material things. They sought to protect Americans in their beliefs, their thoughts, their emotions and their sensations. They conferred as against the government the right to be let alone, the most comprehensive of rights and the right most valued by civilized men. To protect that right, every unjustifiable intrusion by the government upon the privacy of the individual, whatever the means employed, must be deemed a violation of the fourth amendment, and the use as evidenced in a criminal proceeding of facts ascertained by such intrusion must be deemed a violation of the fifth.

Now, in the McCarthy period, and particularly in the 1950's, the courts were plagued by cases involving the use of secret information, backed and used to adversely affect the clearance rights of Government employees, consulting scientists and scholars. Such data banks are now becoming more widespread in business and industry, and are becoming more repressive in matters of credit, loyalty and so forth. Granted that information of this kind can be assembled for good purposes, there are still uses to which it should not be put. The unwarranted use of such critical information often irreparably harms the standing of the affected individual in the community, and perhaps for the rest of his life. It creates dissension between individuals and groups, and makes for disunity. It is a matter of great public interest and should challenge the State as well as the individual or group involved.

It has recently become the official concern of other freedom loving nations. Only last Saturday the following item concerning England appeared in our local press:

> The British Government promised today to set up a broadly based committee to recommend legislation for establishing individual privacy as a legal right. After a day long debate in the House of Commons, during which no member dissented on the need for a right to privacy, Honorable Secretary James Callahan said he was naming Kenneth Younger, a former Member of Parliament, as Chairman of a Group of Representatives of Parliament, press, the legal profession, and the public to make an extensive inquiry. That it will agree on the principle and produce draft legislation was taken as a near certainty. The principal target was the activity of private eyes, credit snoopers and private investigation which amass and sell to inquirers vast amounts of personal information on individuals applying for jobs, loans, installment purchases or business connections.

It was argued that, and I again quote from the article:

> That laws against theft and trespass that once protected against invasion of privacy have been outmoded by modern technology, telescopic canvass, computers, parabolic antenna, phone taps, recording machines, and bugging devices. The author of the bill proposed forbidding on pain of damage payments, employment of such devices for illegal purposes.

Now, no discussion of the individual, the machine and the State would be complete unless we also touched upon the effect of the machine on the State insofar as it affects the environment in which we live—pollution of the air, the water, the very food we eat, and the destruction of our natural resources. These facets of destruction affect every individual. As much as the automobile, airplane, and other manufacturing industries have contributed to the development of our Nation, they also carry a heavy load of responsibility to alleviate the conditions of smog, water pollution, and food contamination which they have brought into being.

The atmospheric conditions which move smog from place to place do not stop at State lines. Nor do the interstate rivers stop at any border. They affect the lives of Americans. Wherever they course they diminish to some extent the right of everyone to life, liberty, and the pursuit of happiness. It is a national problem, which demands the attention of the Federal Government as well as that of the States and those responsible for the conditions.

Happily, the President and the Congress have both recently manifested not only a desire about these conditions, but also the intention of eliminating them. Their problem is a hydra-headed one. It calls for a national commitment equal to that which enabled us in a few years to go to the moon, and the participants of it need not be limited to scientists and technologists. There is a place for every citizen; in one way or another we have all contributed to the conditions, and therefore have partial responsibility for eliminating them. It is to discuss such problems, as well as the beneficence of scientific and technological advances that I assume this meeting is being held. It is a matter of the greatest importance. [Applause.]

Chairman MILLER. Thank you very much, Mr. Chief Justice, and on behalf of the committee I would like to present you with this resolution, acknowledging your presence here, something that you can keep in memory.

Mr. WARREN. Thank you very much, Mr. Chairman.

Chairman MILLER. It is now my deep pleasure to introduce a very distinguished gentleman. Toward him, I can feel a little bit fatherly because I was in Congress before he got here. He was assigned to the committee on which I served. I think that in those early days I might have led him by the hand along the path. But then he has moved fairly high in the ranks of Congress. I do want to say that he served on this committee, although he was the floor leader of the House he retained his membership on this committee just as long as he could. Then he had to give it up. It is my pleasure to present the Honorable Carl Albert, Democratic floor leader of the House. [Applause.]

STATEMENT OF HON. CARL ALBERT, MAJORITY LEADER, U.S. HOUSE OF REPRESENTATIVES

Mr. ALBERT. Mr. Chairman and you will always be my chairman, Mr. Chief Justice, my colleagues, distinguished ladies and gentlemen, one and all, I became very impressed in my imagination almost got the best of me as the former Chief Justice of the United States opened his remarks. I began to wonder why we shoudn't use the computer in politics, and since due to the last election we have to have a Republican, why we shouldn't move Abraham Lincoln back in the White House.

But then I began to worry, because I suddenly realized that unless the computer could eliminate John Wilkes Booth, Spiro Agnew would be President of the United States. [Laughter.]

Thank you, Mr. Chief Justice for your remarks.

Almost 13 years ago, the House created a Committee on Science and Astronautics. It was an act that demonstrated a greater wisdom than many of us realized at that time. The course of events in our country with regard to science and technology has had a profound effect upon our Nation and our people, and I think upon the people of the world. This committee has, since its beginning, demonstrated a deep concern for that effect. As the chairman has said, I had the honor of serving on this committee, and I had the honor to introduce the resolution creating the Committee on Science and Astronautics. I retain a deep personal interest in everything that the committee does.

The importance of the Panel on Science and Technology is greater, perhaps, than many people in this room can perceive, its influence is so broad and penetrating. The discussions that have been held here have contributed mightily to enlarging the Committee's stature, and more important, has had to give the Members of the House a broad and deep understanding of scientific and technological matters in discharging their responsibilities as legislators. This committee was the first and remains the only congressional committee to have an advisory panel, through which a full and candid dialog between the scientific and political communities can be conducted for the benefit and improvement of our society.

It is a great pleasure, Mr. Chairman, for me to welcome this distinguished group here today, and I look forward to being with you in such meetings in time to come. Thank you. [Applause.]

Chairman MILLER. Thank you very much, Mr. Floor Leader. I will now turn the meeting over to the gentleman who has done more than anyone else to spearhead the work of this committee in this field, and a man whose contribution to scientific work within the Government is greater than any other that I know. Mr. Daddario. [Applause.]

Mr. DADDARIO. And without any hesitation at all, I turn the meeting immediately over to Dr. Bell.

Dr. BELL. The vision which the Chief Justice gave us of computerized sports brings to mind, of course, the old phrase of William James, which he thought at one time that sports would be the moral equivalent of war. One now has the possibility of being able to take all war and fight it in simulation, rather than carry it out in reality. If someone would simulate wars we might be able to do much better than we are doing today.

Let me turn fairly quickly to the topic on hand, and see if I can in a minute or two set the stage of where we are.

Yesterday we had two papers which tried to sketch some broad social changes taking place in contemporary society. The general notion was that in the next 30 years we are heading into what has been called a possible industrial society, and in that possible industrial society it is characterized by a number of features, the two most important of which is the proposition that theoretical knowledge, or a codification of theoretical knowledge plays a crucial role in the organization of that society; and second, it is a kind of society characterized essentially by the dominance of information rather than energy which has been the feature of industrial society.

And information itself becomes a form of power, and if information is a form of power or one of the means of power, the problem of the control of information or the examination of information as potential power becomes a serious one.

The second paper by Professor Beer raised the question of the need for what he called metasystems, or what might be called generally controlled systems in the society, that the very nature and complexity was such that unless we had the growth of these kind of self-examination metasystems, the subsystems of the society, which he called esoteric boxes, would become more shriveled perhaps and run down. But more than that he raised the proposition which we didn't have a chance to discuss, which was quite important, that without these metasystems you couldn't have what he called custom-tailored information for individuals. He was putting forth the proposition, in effect, that the condition for greater degree of individualization in society was the creation of larger metasystems, and that, too, seems to be a very important kind of argument which we have to deal with.

Now we turn this morning to what might be called the internal structures of the communications systems, and raise questions which 10 years ago perhaps would have been looked askance at within the scientific community—perhaps not askance, but looked at with some degree of puzzlement—namely, the relationship to values.

We begin here perhaps now more inevitably and naturally the discussion of technological and scientific change within a value context, rather than simply looking at the technical components themselves. And the two papers this morning address themselves first to the kind of perils which are involved in the information process, and second to the kinds of ideals which have been guiding this society and the adequacy of these ideals. The first paper, which has the provocative title of "The Self-Liquidating Ideals," is by Dr. Daniel J. Boorstin, who is a former professor of history at the University of Chicago, and now the Director of the National Museum of History and Technology at the Smithsonian Institution.

The paper on the biographical briefs of the participants give us in rather great detail the achievements of Dr. Boorstin, including the large and wonderful books called "The Americans," which have been a series of books which try to encompass our natural experience. It doesn't mention, however, a more recent work which I suspect he has great satisfaction from, which will be published very soon, which perhaps is part of his own pixieish kind of humor which underlies some of the work he is doing which is called "The Sociology of the Absurd," and I suspect it is with that kind of tongue-in-cheek systems he is going to rise to the problem of self-liquidating ideals. Dr. Boorstin. [Applause.]

STATEMENT OF DR. DANIEL J. BOORSTIN, DIRECTOR, NATIONAL MUSEUM OF HISTORY AND TECHNOLOGY, SMITHSONIAN INSTITUTION

Dr. Boorstin. This morning I would like to make a few remarks about the relation of our ideals to some of the peculiarities of our history. I am concerned with pointing out some distinctive features of life in America, without necessarily generalizing about them or from them, to the rest of the world.

Every society has its own kind of values, its own way of measuring what is good or bad, its own way of deciding whether it has succeeded or failed.

And I think that our approach to values in the United States is one of the most distinctive things about us. Whatever we may think about our values, whether we think that they are static or changing, good or bad, ill defined or clear, I think we can all agree that one feature does characterize the American approach to values, namely, our tendency to worry about our values. And of course we are dramatizing that this morning, and we were already talking about it yesterday.

Worrying about our values, I suggest, is more than a characteristic headache of our time. It is a byproduct of long and potent forces in our history, and of many peculiarities in American life. In our own time it is peculiarly a byproduct of the American concept of a standard of living, of the American attitude to technology, and of American success in technology.

We Americans have been led to the pursuit of some self-liquidating ideals. Myriad circumstances in our history have led us in that direction. I have explored some of them in a study of American civilization called "The Americans," and the notions I offer here this morning are explorations of some ideals which I hope to pursue in greater detail in "The Americans: The World Experience."

A self-liquidating ideal, I suggest, is an ideal which is dissolved in the very act of fulfillment. Many of our most prominent and dominant ideals have had just this quality.

Let me start with a few earlier examples, perhaps obvious examples, which may have additional strength for that very reason.

The earliest example is in the very first appeal of America as a New World. The first charm of the continent was its newness. The Great Seal of the United States, still found on our dollar bills, bears the motto "Novus Ordo Seclorum" ("A New Order of the Centuries").

But when the new Nation in a New World flourished and endured, it became old. By the later 20th century we were among the oldest of the new nations of modern times. Our Federal Constitution, which in 1787 seemed so uncertain an experiment, now is the oldest written Constitution in working order.

How to stay young? This problem plagues nations as well as individuals. But it plagues us more than other nations.

How can we keep alive the experimental spirit, the verve and vitality, the adventure lovingness of youth? Nations which glory in their antiquity—an Italy which traces its founding fathers back and into the heavens to Romulus and Remus, the twin sons of Mars, and to a semimythic Aeneas; a France which reaches back to a Saint Louis and Saint Joan; a British whose genealogy includes a legendary King Arthur—those nations have other special problems. Despite occasional revolutions and pretended revolutions, in modern times these nations, even when they have gloried in newness, have tried to sanctify it with the aura of antiquity. They have aimed to historicize their myths.

But our Nation, founded in the glaring light of history, from the beginning set itself a task of renewal. Our Pilgrim Fathers and Founding Fathers hoped to give the men of older worlds a second chance. But could any world—even this brave New World—stay forever new?

It is not only this first and most obvious of American ideals which has seemed to be self-liquidating.

The newness of our Nation would come, as we were told, from the fact that the United States would be as varied and as multiplex as all mankind. We would be (in Whitman's phrase) "A Nation of Nations." It became a tenet of American faith, restated by Lincoln, that we were "the last, best hope of earth." Our Nation was to be (as Emma Lazarus proclaimed in her inscription on the base of the of the Statute of Liberty):

> Mother of Exiles. From her beacon-hand
> Glows world-wide welcome * * *

The whole earth would be our womb. Our wealth and strength would be in our variety.

Of course there were other regions of the world—the Balkans, the Middle East, South Asia—which also were a melange of peoples and languages and religions. What would distinguish the United States was that we would give our varied peoples the opportunity to become one. As they were dissolved in the American melting pot they would become part of a single community.

But suppose we actually succeeded. Suppose we brought all the immigrant-world into one great new nation. Suppose we managed to Americanize and assimilate the varied peoples of the world. What then?

Inevitably—and ironically—success would mean a new homogeneity. If the Nation really succeeded in drawing together all these peoples, giving them a chance to discover their common humanity and to forget the feuds and ancient hatreds that had held them apart, how could it fail to dissolve much of that rich variety, that pungency which itself justified building a nation of nations?

This danger was not purely theoretical. The 19th century, which brought us tens of millions of varied immigrants—from Ireland, Italy, Poland, the Balkans, the Middle East, and elsewhere—concluded in a paroxysm of fear and puzzlement. Immigrant Americans, almost as soon as they had established residence here, began to fear that the Nation might not be homogenous enough. They took for their own the slogan "Americanize the Immigrant." The Immigration Restriction League, in the 1890's, included many of the Nation's most respectable political leaders, industrialists, labor leaders, educators, scholars, and authors. And Congress published 40-odd volumes of hearings on the evils of immigration, and the dangers of immigrants. The new immigration policy of the 1920's then proclaimed the dissolving of the adventurously pluralist ideal.

The pluralist ideal was being abandoned, not merely because some people believed it was wrong, or could never succeed. A better explanation, and more relevant to our purpose this morning, of what was happening was that the effort to build a strong, nationalistic, community-conscious people from this international miscellany had substantially succeeded. Or at least it had succeeded to such an extent that millions, whose immigrant parents had arrived only a little earlier, came to believe in a newly consolidated Americanism, which left no place for later immigrants—or for others who were conspicuously, if superficially unlike themselves. The organized labor movement, which included and was led by immigrants and the children of immigrants, then joined with New England bluebloods to restrict immigration.

The years from about 1880 to about 1930 witnessed the greatest confusion in the shaping of an American ideal of nationhood. First- and second-generation immigrants collaborated with the descendents of earlier, more respectable and more prosperous immigrants, to define what was called 100-percent Americanism. At the same time a new American sociology, which was substantially a science of the minorities, arose to give respectability and aggressiveness to pluralism.

Many Americans moved from the older ideal of assimilation (that is, "Americanize the immigrant") to the newer ideal of integration (allowing each group to remain integral, and to glory in its distinctness), without themselves being clear about how all these ideals would fit together. That was the first heyday of the balanced ticket. It was the age of the second Ku Klux Klan, with its white racism and antisemitism and anticatholicism—and, in response, it became an age of aggressive ethnicity. The grandchildren of immigrants, in search of their roots, fabricated a newly assertive and chauvinistic sense of separateness. Many otherwise respectable Americans were surprisingly tolerant of the racism of the Ku Klux Klan. This confusion survives into our own age, and helps explain the aggressive ethnicity and racism of groups like the Black Panthers, and again the shocking toleration of destructive and illegal acts committed under the cover of racial separatism.

The battle over immigration then left scars among minorities not unlike the sectional scars left by the Civil War. On the whole, and perhaps inevitably, the battle was won by the assimilationists—who thereby had helped fulfill (and liquidate) the American ideal of pluralism, without being clear about what should take its place.

Perhaps we are now living through another of our American cycles of self-scrutiny and conflict. Perhaps ours is another painful age when one of our self-liquidating ideals begins to be liquidated. And perhaps, in our age, the liquidation is tied to technology.

Some of the current problems I now suggest arise from our efforts to bring the best material things to everybody. When before had a society set itself the ideal of bringing to every citizen the delights and satisfactions of the best products of its technology?

"Every man a King"—Huey Long's slogan—was not far from the extravagant American hope.

I will offer only two examples of how we have tended to be frustrated by our successes.

(1) A wilderness holiday for everybody: The problem of our national parks.

First, there is no more distinctive or more successful American institution than our national parks. And I can say this, and my wife and I can both say this with deep feeling, because the natural parks have been a very important part of our lives, as they have been of many other Americans. The National Park Service, within the Department of Interior, and under the admirable leadership of George Hartzog, has demonstrated an efficiency, an imagination, and a democratic largeness of spirit to inspire all of us. Yet, despite their best efforts, and even because of their brilliant success, we face here again the paradox of a self-liquidating ideal.

A purpose of our national parks, beginning with the establishment of Yellowstone National Park in 1872, has been to preserve our wilderness areas for the benefit of all the American people. Rocky Mountain National Park, Grand Teton National Park, Glacier National Park, Yellowstone, and Yosemite, among others, aim to make accessible to all Americans the delights of the pristine continent. Our national parks now comprise over 25 million acres and receive some 40 million visitors each year. Their reach to the American public would have been impossible, of course, without the American standard of living, which includes the improvement and diffusion of the automobile, an unexcelled national network of highways, and a high standard of leisure, with regular and extensive paid vacations.

The national parks, themselves part of the American standard of living, have made it possible to democratize the wilderness. An American, then, does not need to be wealthy, to own a large estate, or to afford a retinue of servants to reach and enjoy thousands of acres of the most remote, most unspoiled, and most spectacular landscapes in the Nation.

But—"Will success spoil the national parks?" This is the question asked by Mr. Robert Cahn in his important articles recently published in the Christian Science Monitor (and republished in a helpful booklet with an introduction by George Hartzog). Our wilderness acres, as Mr. Cahn points out after an extensive survey, a study of over a year, simply because they are so attractive and so accessible, have begun to become traffic jams. Living conditions in the campsites of Yosemite Valley and around Lake Yellowstone—with laundry lines hanging from tent to tent and one camper unwittingly putting his elbow in his neighbor's soup—begin to resemble the congested cities from which these people fled.

In 1967 serious crimes in national parks rose 67 percent compared with a 16-percent crime rise in American cities. And other statistics suggest that the problems of the cities are accentuated even in the natural parks.

The democratization of the automobile and the democratization of the wilderness countryside threaten to destroy the very landscapes that we want everybody to have access to. Is a wilderness holiday for all Americans a self-liquidating ideal?

Let me turn to another example, one which may seem a little askew, a little more in the mainstream of our everyday life, and that has to do with the automobile, and what I would call the democracy of things, or the movement from the Model T to the annual model.

Henry Ford's dream was to make a new and better kind of family horse—that was his expression—a car which everybody could afford and which would last forever. Essential to his plan, of course, was perfecting his Model T. Although he was experimental in developing his car, he believed that once the design was fixed, the object was simply to find ways to make it by the millions.

It was essential to his ideal that all the cars should be alike. As he saw it, mass production (what he called "the democratization of the automobile") required standardization, and standardization meant turning out a single uniform product by the millions. "The way to make automobiles," Henry Ford explained in 1903, "is to make one automobile like another automobile, to make them all alike, to make them come through the factory just alike; just as one pin is like another pin when it comes from a pin factory, or one match is like another when it comes from a match factory." That is Henry Ford speaking.

To Ford this meant finding ways to turn out millions of Model T's. He was confident that he could succeed. In 1909 a friend warned Ford that the automible would create a "social problem" by frightening all the horses on the highway and create chaos in that way. "No, my friend," Ford replied, "you're mistaken. I'm not creating a social problem at all. I am going to democratize the automobile. When I'm through everybody will be able to afford one, and about everyone will have one. The horse will have disappeared from our highways, the automobile will be taken for granted, and there won't be any problem."

Toward this end Ford focused his efforts on making his car as cheap as possible, making repairs inexpensive and easy. He continued to believe it was his mission to turn out millions of copies of the same durable product. He was still saying the same thing in 1922, and this is what he said:

> We cannot conceive how to serve the consumer unless we make for him something that, as far as we can provide, will last forever. We want to construct some kind of machine that will last forever. It does not please us to have a buyer's car wear out or become obsolete. We want the man who buys one of our products never to have to buy another. We never make an improvement that renders any previous model obsolete. The parts of a specific model are not only interchangeable with similar parts on all other cars of that model, but they are interchangeable with similar parts on all the cars that we have turned out.

He meant what he said, and he had the power to make his dream come true.

Ford had begun producing his Model T in 1908. On May 27, 1929, the 15 millionth Model T was produced. And in that year, the number of Model T's still registered (and therefore still presumably on the road) came to 11,325,521—almost 11 and a half million cars of the total 15 million Model T's were still on the road nearly 20 years after the first Model T. But the Model T was in trouble.

By 1920, Henry Ford's success in democratizing the automobile, in building an inexpensive car that would last almost forever, had produced a vast second-hand car market. And if you want to be reassured that God must exist, all of you should on some occasion read the story of the surprise and astonishment with which the automobile manufacturers discovered that the selling of automobiles eventually produced a second-hand market. Dealers faced a new kind of competition—no longer from the horse, but from the millions of still-usable used Fords. And, at the same time, the American buying public was stirred by a rising standard of living, by rising expectations (encouraged, incidentally, by Ford's $5-day wage which he hoped would make it possible for still more workers to buy Fords), and by a love of speed and a love of newness, Americans demanded something new.

But Henry Ford's spectacular success was in producing a static model. The problems of style and consumer taste had hardly occurred to him. He was a genius at production. And with the help of his own brilliant staff, aided by the pioneer factory designer Albert Kahn, who has not been sufficiently celebrated, and others, he had developed the assembly line and so had taken a giant step forward in elaborating the mass production which Eli Whitney had pioneered a century before.

Ironically, his faith in the Model T was an Old World faith. His belief in the perfectible product rather than the novel product, his insistence on craftsmanship and function rather than on consumer appeal eventually left him behind. His genius had heralded a new age beyond his imaginings—and not at all to his taste.

This spirit of the new age was expressed in what Charles F. Kettering and Allan Orth in 1932 called the "new necessity." And this is what they said:

"We cannot reasonably expect to continue to make the same thing over and over," they predicted. "The simplest way to assure safe production is to keep changing the product—the market for new things is indefinitely elastic. One of the fundamental purposes of research is to foster a healthy dissatisfaction." The leader toward the new ideal was Alfred P. Sloan, Jr., who shifted the point of view from the maker to the buyer. After Sloan went to General Motors, he developed a new and characteristically American institution. It is so familiar now that we hardly think of it as an institution.

And when I first came upon it, I was somewhat surprised to see how self-consciously it was created. Somebody actually invented the annual model!

The spirit and purpose of the annual model were, of course, quite the opposite of those of Ford and his Model T. "The great problem of the future," Sloan wrote to Lawrence P. Fisher (of Fisher Body) on September 9, 1927, "is to have our cars different from each other and different from year to year." The annual model, then, was based on creating expectations of marvelous, if usually vague, novelties always to come.

Sloan and his able collaborators at General Motors set up a special new styling department which soon employed over 1,400 people. General Motors showed a new concern for color, and even invented enticing, aphrodisiac names for old colors. Now for the first time the automobile designers included women. "It is not too much to say," Sloan explained, "that the 'laws' of the Paris dressmakers have come to be a factor in the automobile industry—and woe to the company which ignores them."

The invention of the annual model did, of course, create a host of new problems of planning and of production, and nuances of judgment were required.

How much novelty would the consumer tolerate? How to titillate and attract the buyer without frightening him by too much novelty too soon? A very good example of this problem was the bulgy Buick, which came to be nicknamed "the pregnant Buick." This was an admirably functioning car but a disaster on the market. According to Sloan it was the result of a design mistake of not over 1¼ inches in excess body curve.

The effort to democratize the automobile proved self-defeating—and illustrated the problem of self-liquidating ideals—in at least two other ways.

I have been told that we have a time shortage here, and I have been urged to abridge, but I will move on briefly and just mention some of these points which are in the printed version of my paper. I would remind you that one of the things that Sloan had to develop in order to make annual model function was a ladder of consumption. When he went to General Motors there were numerous General Motors cars with overlapping markets, and it wasn't clear, for example, that a Buick was a more desired or more expensive car on the whole than the

Chevrolet. So he then created a ladder of consumption. He started with a price schedule, and did the extraordinary organizing feat of developing the plan of the factory so that automobiles could be produced to fit the prices, which of course was exactly the opposite of the way Henry Ford had approached the problem.

And another aspect of the creation of the annual model, perhaps the most profound and symbolically the most important, for our discussion here this morning, is what I would call the attention of novelty. By the late 20th century, the newness of the new models had begun to consist in dubious minutiae, such as concealed windshield wipers, concealed headlights. To devise every automobile so spectacularly different from the annual predecessor that buyers would want to buy it, taxed the ingenuity of designer and production engineers. They ran the gamut of human and diabolical ingenuity. So that before long the tendency of certain foreign manufacturers, Volks and Mercedes Benz, to retain the old model, actually produced a new sales appeal.

We can't help recalling then the plaint of Henry Ford, which was a kind of prophetic dyspepsia—"Change is not always progress," he said. "* * * A fever of newness has been everywhere confused with the spirit of progress."

Ford himself had not imagined that the frenetic quest for novelty might make novelty itself pall. The success of the static model had itself created a demand for the annual model, for annual novelty, but the questions of annual novelty had made novelty itself pall. The annual model itself was being dissolved by success. What would come next?

Now, let me try to suggest a few of what might be the general consequences of these facts about our history and I present them tentatively as facts in relation to characteristic problems and promises of our society.

These are only parables of what seem to me to be some peculiarly interesting features of the relation of American society to American values. I prefer the word "ideals" because it is a more common word.

There are many other comparable examples that might occur to you. For example, we pursue the ideal of universalizing the opportunity to travel, which then leads us to make all places more alike and hence less worth the trouble of going to. Or we have the ideal of indefinitely increasing leisure, which leads people to try to keep life interesting by making leisure into work.

Or we increase the means and the modes of communication, and that leads people to communicate more and more of what's not worth communicating.

Perhaps the explanation of self-liquidating ideals is inherent in the very ideal of increase, which ancient philosophers of course reminded us always would lead to excess. Perhaps it is inherent in the ideal of democracy, which aims at the very same time to fulfill each unique individual and yet to abolish distinctions among individuals. Perhaps it is only another example of the universal tendency of love to destroy its object.

But whatever the deeper, cosmic causes, the phenomenon, I think, is obvious. The fact of self-liquidating ideals may help us understand some of the peculiar recurrent strains, and some of the peculiar challenges, of life in the United States today.

Old World cultures have tended to be cumulative—and to think of themselves as cumulative. Aristocratic cultures tended to appeal to ancient orthodoxies. To believe in the glories of France, then, is to believe in the possibility of adding up all the disparate, conflicting achievements of different epochs of French history.

Their glory is to widen the spectrum of their achievements. This requires the adding up of opposites—adding the achievements of a revolutionary republic to those of an Ancient Regime.

And here I would contrast them to the American Revolution. Old World revolutions have tended to produce explicit orthodoxies, which aim to define the good society for all time to come, until the next revolution arrives.

But, starting in a new world, as a new nation, we remain a renovating culture. The federal experimental ideal was to make it possible to try new objectives. One of the most remarkable, and least heralded, features of our Federal Constitution was its explicit provision for amendments.

Our recurrent need for renewal gives us some peculiarly American headaches and opportunities. For in our history there seem to be natural cycles of self-flagellation. We are now suffering through one of these. Perhaps such recurring cycles may not come from the total failure which the self-flagellants insist upon. Perhaps they mark another age when ideals which have been substantially achieved have begun to be liquidated.

Perhaps we are witnessing an age of the self-liquidation of the ideal of the American democracy of things. Perhaps more and more Americans surfeited by objects, many of which actually remove the pungency of experience, now begin to see the ideal—the ideal of everybody having the newest things—being liquidated before their very eyes. Perhaps the annual model has begun to lose its charm. People are so frequently and so insistently reminded of the supposedly desirable differences between indistinguishable products, who hear the blaring of trumpets to herald a revolutionary new cold water detergent—these people begin to be cynical about all novelty.

When the getting of more and more comes to mean less and less, when more and more Americans begin to worry over the comparative merits of their increasingly elaborate automatic appliances performing ever more trivial functions, is it any wonder that more and more Americans become skeptical of the salvation that lies in wealth? Is it any wonder that more Americans should begin to rediscover the basic uses of American wealth at the lowest levels of consumption? Who can doubt the satisfactions of having things or giving things when they relieve starvation or undernourishment? The poverty Americans, who in recent years have been given the new dignity of a recognized "minority group"—and there are many problems connected with this, too—are perhaps the only Americans for whom the American consumption ideal has not been self-liquidating. They have not participated either in its benefits or its frustrations. Is it surprising then that Americans nowadays show so striking and sometimes even so militant a concern for poverty in America?

A second characteristic and growing concern of our age is the focus on environment. The word has suddenly become so popular that people act as if the very concept of environment were a creature of the mid-20th century. People might also begin to speak of the age before the 20th century as the "preenvironmental age."

May not our new concerns for the environment perhaps be another symptom of our discovery that the ideal of everything for everybody is somehow self-liquidating? By concern for environment these days we mean, of course, a concern over pollution of water and air, over congestion and crime, and urban disorder—in other words, over the unpredicted and uncalculated costs of building a democracy of things. So we concern ourselves less with the exhilarating prospect of making more things for everybody than with an effort (in President Nixon's phrase) to "restore nature." And we aim to cancel out some of the consequences of making so many things for everybody.

In the perspective of our history it is not surprising that we should find ourselves seeking to redefine ideals for the American Nation. Perhaps it would be more comfortable to live in an age when the dominant purposes were in full flood, when the hope for fulfillment had not been overshadowed by the frustrations of fulfillment.

But may not much of the peculiar greatness of our Nation consist in its uncanny and versatile powers of renewal? Again and again our Nation has shown an astonishing capacity for setting itself hitherto unimagined ideals, and then proving that these ideals can be fulfilled. And then setting still others. The burden and the challenge of being an American consist in these recurrent tests of our power of renewal. Paradoxically, this is our most distinctive and most potent tradition.

Thank you.

Dr. **Bell.** Thank you very much, Professor Boorstin. We are going to rearrange the program somewhat in order to allow sufficient time for discussion of Professor Boorstin's paper, so we are going to put Mr. Armer's paper this afternoon and group it together with the two on education, which will give us sufficient time, because we have 3 hours this afternoon, and we will have Dr. Wiio, our guest, comment toward the end of the session this morning.

So we are going to leave most of this time, since it is now 10 after 11—we adjourn at 12 or so—for the discussion of Dr. Boorstin's paper, and then some time for Dr. Wiio's observation.

I won't try to summarize the rather protean paper of Dr. Boorstin. The first major question, which is at the beginning of the paper and at the end of the paper, is, how does a nation maintain an experimental attitude? How do you keep a renovative culture? It seems to me this is the most central and crucial of all the problems which confront an academic and scientific community.

And the subsidiary question which comes through from the sketch that he has done, for example, of the role of the automobile, which has been the major innovator in technology—the problem arises to what extent is technology embedded as it is in a certain kind of marketing culture, to what extent does the technology begin to dictate values to the society rather than become a means to realizing certain values in this regard?

And thirdly, if one takes the example of the national park, a great resource for the expansion of the spirit, to what extent do these trends in a modern industrialized or postindustrialized society indicate the loss of personal space, or the loss of personal individuality?

These, it seems to me, are the three very frightening questions we have to confront this morning. Dr. Spilhaus, do you want to begin?

Dr. SPILHAUS. Mr. Chairman, this profound and delightful paper of Dr. Boorstin's says to me that the principal role that all ideals become self-liquidating is simply because the population goes from excess to excess.

That may be an oversimplification of what he said, but nevertheless that is what gets through to me. It astounds me that—well, let me make a remark about yesterday. Yesterday we had two brilliant papers by Kahn and Beer. Kahn's was—I like smorgasbord. I learned to like it in Minnesota. But it was a kind of a smorgasbord of problems and predictions without priorities or proposals.

Beer, on the other hand, and I use the word in the highest sense of a compliment, attacked the problem of the metasystem from an engineer's point of view. Maybe we can't do it perfectly, but that is not a reason for not trying to do it, says the cybernetician.

I agree with that. On the other hand, I would say that we would not need these metasystems with their attendant dangers if we didn't have a metasociety. The fundamental disease we haven't discussed at all in this room, and this is the excess of population. Last year at this meeting we discussed the problem of the cities, a symptom of excess of population.

This year we are discussing information, its management, its excess, also a symptom of excess of population. Pollution has been discussed time and time again, but without mentioning the fact that man is not only the greatest polluter but he is, by his very excess, the greatest pollutant.

Because a pollutant, the definition of a pollutant is anything, animate or inanimate, which by its excess reduces the quality that makes human living, and as long as we are not bringing the necessary human service to the people we have on earth, it means that right now we have an excess of human beings.

Perhaps we did make a giant step forward for mankind when that little step was made on the moon, but what kind of man will we have taken the step for, if there is no space in which he can remain human? I am dismayed at the giant step backward that has been taken in the last few months, by the efforts to discredit attempts at population control, such as the pill.

I think this is a giant step backward, reducing the public's confidence in these admittedly beginning ways of getting at population control. It is only within the last few years that anybody has been able to talk about these things, and I give the credit for this new, uninhibited discussion to the young people, who have prodded us into examining things that we older people thought were taboos.

And now it would be a terrible thing if under the guise of science we discredit the very tools that can hit at the central problem of the world, excess population. It is true that some of the people, I saw on television some disorderly conduct here in these Houses, at the hearings, some of these people obviously were using science as a cloak for their quite legitimate and moral reservations, but moral reservations are legitimate for discussion, but should not be discussed under the cloak of science.

I think that we are taking steps backward in many of the well-meaning examinations of the safety, the utter safety of everything.

We are forgetting that life is essentially a balancing of risks, and it is just a fad today to make everything absolutely safe.

Well, if we do that we will indeed have nothing, and I don't think the quality of our life will be improved. I am sorry Mr. Fulton isn't here, because I don't like to make these remarks behind his back, but yesterday he did, in a way, present a plea for balance. He said he will have a little smog to keep the steel prices down. That is not a great ideal, but it does show a balance.

He also said he was for motherhood. Well, I am for balanced motherhood, but I am not for uncontrolled mass motherhood. But knowing Mr. Fulton as a consummate politician and having been told that the art of politics is that of compromise, perhaps he will buy a scheme that has already been adopted, a daring scheme adopted by the Government, on the cigarette packs, the caution, and maybe we will print on that nice space on young girls, between the bikini and bra, "Caution: Motherhood may be hazardous to your health." [Applause.]

Dr. SPILHAUS. Mr. Chairman, I am one of these on the panel who comes, looks forward each year to these sessions. We have had extraordinarily good sessions in the past. Yet last year it was cities, this year, this discussion, which is very important.

I hope that next year we will have managed to creep up to the central problem on earth, the control of population.

Dr. BELL. May I raise a question with you, Dr. Spilhaus, because I would like to encourage some dialog on this. I don't think there is any question that one of our problems is the sheer increase in numbers. Since 1945, we have had 90 million children born in this country alone, for a net increase of about 60 million after the decline of the death rate.

It comes in the society which is less equipped to deal with it, because in the past we were able to expand, so to speak, segmentally. But this increase comes permanently, comes on top of existing things. If I read Professor Boorstin's papers, something else comes in, and in most of the self-liquidating ideals, there is an old phrase which was used which says sometimes we are dizzy with success, and to some extent the argument he is making in the papers is that there is something in the nature of the American system which gives us a sense of being dizzy with success, which somehow topples us once we have reached a previous goal.

So I raise the question with you, whether even if we were to succeed, difficult as it is, in population control, would we then perhaps simply find ourselves with other problems and not confront the underlying argument which seems to me is, what is at stake here in Professor Boorstin's papers, that in the past it has been the pressure of homogenization.

Immigrant, then it has been the question of material success which has been the automobile, now we are concerned with the environmental problem of pollution. There is something deeper which is part of the American experience, and I come back, it seems to me, to the matter of his papers itself, how do you maintain an open attitude in a society, how do you maintain an open society and how do you maintain a society which is no longer heavily bureaucratized, heavily encrusted with vested interests, heavily moving in one or another direction?

And while I agree completely regarding the specifics of the problems of population, I just raise a small voice which says, let us not also simply look at one thing, and as soon as we solve this then in a sense we have been on our way.

Dr. **Spilhaus.** I quite agree. There are two problems. I think that the population problem is the central one, the most difficult one. It probably will take us the longest time to solve, and therefore we should start it first. There is, however, the second problem, the matter that we discussed last year, the matters we are discussing today, that we must, of course, take care of the present people on earth, and this is the engineering problem of doing for what we have.

But the other problem is the one that is so often neglected.

Dr. **Bell.** Dr. Boorstin, you want to comment?

Dr. **Boorstin.** Yes, I have known Dr. Spilhaus' work for a long time and had great admiration not only for its profundity but for its wit, but I had never thought that he would have the ingenuity to put me in the position of being equally at fault whether I was for or against motherhood. He has succeeded in doing that, however.

Of course, there is a problem. I would have to say that I would be cautious about thinking of "the solution" in quotation marks of the population problem as being an answer to this paradox. I don't think it is. I think that the belief that it is a solution is itself an American temptation, and one I hoped we would resist.

I think, however, that when Dr. Spilhaus speaks about the problem of increase he is right there. This may be central to the problem, and I would suggest (sharing Dr. Bell's suggestion) that the upshot of all this, the moral of it, for us Americans today and for our legislators and citizens, is to try to find ways for preserving the experimental spirit.

There is another aspect to it, too, however, which is particularly suggested by Dr. Spilhaus' rather familiar comment about how great all young people are today. This is the way we punctuate our sentences, and I am not sure it helps us very much.

But I think that one of our problems is how we can be sufficiently cumulative, how in a society that is constantly stuck with this cycle of renewal, it can remain possible without being reactionary or paralyzed, to keep in touch with the accumulating values of the past. This is a problem which the Chief Justice mentioned in relation to the Constitution.

The Constitution is a symbol of this. And I think that one of our main problems, and it is a problem to which very few people are addressing themselves today, but which I think more of us should confront. With the coming Bicentennial of the American Revolution I hope more of us will think about how we can, in an experimental and progressive spirit, draw on our past more effectively than we seem to be able to do now.

And I think one way to do that, of course, is to diffuse more information and understanding about it on our part and make more and more respectable the acquisition of information about the institutions of our past. Now, another aspect of it is, how can we keep our present institutions renovative enough? And I think that there are a number of practical ways in which we can do this, and I would like to suggest some of the areas in which the activities might be most desirable.

In the area of education, for example, our institutions must have a flexibility to enable them to help define the newly emerging values of the society. This is true of one after another of our institutions. It seems to me that it is an assignment for our legislatures to find ways to keep our society flexible. Perhaps these meetings are themselves an example of an effort to build a renovating attitude toward our values.

It requires a flexibility in our institutions and a willingness to imagine that institutions don't have to continue to perform precisely the same functions which they performed in the past. This gives a new role to research in private industry which has been one of the most active and productive in the area of renovating.

It gives a new role which I think has not been adequately performed for our churches, and it gives a very important role to our universities and schools, but one of the things which must be remembered in this connection is that no institution can serve any purpose if it doesn't exist.

And if we burn down our universities or if we turn them into institutions that are not directed toward the exploration of intellectual purposes, use them instead for settlement houses and so on, they cannot help us serve their proper objectives. So that I think that it is a nice—it is a delicate line.

It is not clear exactly *where* we must walk, but I think *how* we must walk is clear. And I think that it is most important that our legislators and particularly Members of the House of Representatives and members of this committee should help us by devising ways of keeping our institutions flexible and allowing our resources to flow into the different institutions that are performing these renovating functions in different periods.

Dr. BELL. Dr. Dupree.

Dr. DUPREE. As a historian on this side of the table, who has been listening to a fellow historian, I would like to call your attention to what an unusual and important occasion this is, that in a group normally devoted to talking about science policy in the idiom of science policy, we have heard a very good example of the way in which historians talk, members of an ancient literary plain language craft. It is a difficult problem to get some kind of understanding here.

I myself believe very strongly that what Dr. Boorstin was talking about this morning, what Professor Beer was talking about yesterday afternoon, are actually one and the same thing, that we are both talking about the same process, but in entirely different style.

To illustrate this point, let us take the establishment of Yellowstone Park in 1872. This was done not in a vague sort of way, but was the direct product of the activity of American scientists operating within the policy laid down by the Congress and the Government of the United States.

It was the Hayden Survey. It was a decade, the 1870's, which faced the frustrations of fulfillment brought on by the population growth of the United States, and the rapid ability of American scientists to penetrate to the headwaters of every river in the United States, including the Yellowstone and the Snake.

What was created might have aptly been called an esoteric box. It is shaped like a box. And it was completely without metasystem. Yellowstone Park sat there with no means of administration, no means of protection for a generation. Therefore it is the question that the historian has to ask, since he is not really in the business of instant replay, and he hopes he is not simply a matter of providing antiquarian examples, but rather that there is an actual and systematic connection between the establishment of Yellowstone Park and present problems of the environment.

The way a congressional historian might go into this would be in the way that a former graduate student of mine at the University of California is actually going about it, by writing a biography of Horace Albrecht—a great Californian, Mr. Chief Justice, Mr. Chairman, and a great conservationist.

The superintendent of Yellowstone Park 50 years ago, the Director of the National Park Service in the Hoover administration, who was connected with that organization from its founding in 1915.

Anybody who tries to set up a systems approach to the national park problem at the present time must take into account the history that is embodied in that biography. It is not, however, served up in the kind of language that Professor Beer can readily adapt to a computer situation, and from my point of view one of the important things that has to be done in the present situation is to recognize that there are various universes of discourse which are actually talking about the same thing, which have important things to tell one another, and must seek a common language in order for us to be able to talk about them.

Dr. Bell. Dr. Noyes.

Dr. Noyes. Mr. Chairman, I was delighted that finally the subject of education has been mentioned, both by you and Dr. Spilhaus, because in a way we have set ourselves the ideal of educating everybody as far as they want to be educated, and this includes through the university. And part of our trouble today on the campus, I am sure, is due to the frustrations of having almost but not quite succeeded in doing what we set out to do.

So that the education which is now available to a lot of people is no longer so desirable as it used to be. Now, the trouble with our universities, of course, is just what you pointed out in other connections. They have a built-in obsolescence, and the obsolescence is the faculty.

The great universities of this country, the innovators, have always resulted from great leadership, such as William Harper, Adelyn at Harvard, and so forth, just to mention a few, and Ben Weller at the University of California.

But these are the people who had new ideas and they put these new ideas across more or less in spite of the faculty. Now, anybody who has ever been a dean, and God forbid that I should ever be one again, or that has attended faculty meetings, will realize that while the professors may vote Communist or Socialist or what have you, in their own field they are the most conservative bodies of people that I have ever seen anywhere.

And they will always vote, almost always vote against innovation. So, Mr. Chairman, I am glad that we have brought this subject up a little bit, and I think the young people have shown us that the universities do need to change, and while they haven't always done it very gently or very politely, either in my classes or on the campus, in demonstrations, I think we must listen to them and make some changes.

Dr. Green. I was delighted that Dr. Boorstin connected his observation to the Bicentennial, as well as to the field of education, at least in his remarks. He has taken an idea and supported it, I think, in a most instructive and exciting way. He did not generalize. Indeed he explicitly said at the outset that he did not want to, and I suspect that is part of the charm of his presentation, which permits each of us to generalize, and that is one reason we each find his presentation very exciting.

Nonetheless the idea might be extended, if not generalized, and I would like to comment just a little bit on precisely this point that was just made, the extension of it to the field of education.

I think there are some values in the American experience which are aggregate in their character, and there are other values which are essentially distributive. We could put it this way, that there are some things we seek which no particular person can have unless everybody has it.

For example, highways. But there are other kinds of values. There are some things that no individual can have if everybody has it, and one of the things that Professor Boorstin referred to indeed was connection between highways and free and private open spaces.

And open spaces, large and open spaces may be one of those things that no individual can have if everybody has it. But there may be a third kind of category of certain values. There are other things that a person can have even when others do not have it, but which nonetheless one would have more of if everyone else has it.

The point I would like to make is that we don't really know in the American experience which of these categories, which of these really conflicting notions of value it is that encompasses education. Is education the kind of thing that one has more of if everybody else has it? Is it the kind of thing that no one particular person can have unless everybody else has it?

I raise this primarily because I think that there is real sense in the view of the past hundred years of the American experience in education, a real sense in the view that we might have reached a point where our goals are substantially achieved.

We have the system. We have provided many things that we have set out to provide. And I think we may now be somewhat troubled as to what to do with it. The disposition, when we are confronted with goals that are substantially achieved, is always simply to take the same goals and attack them at a somewhat higher level—that is, really take the same goals and extend them.

We have almost in this country attained the point at which we will get no more expansion in secondary education, expressed as a proportion of the population, and I suspect that the mere extension of the long-held American conviction that secondary education should be made available to everyone, the mere notion that that long goal of the American people should now be extended is one reason, but not the only reason, but one of the important factors in why we have a junior college, community college, extended education movement.

Dr. Boorstin also made one other remark that I think is extremely important. He spoke of self-liquidating ideals in a way that makes very cogent and very concrete the experience of many young people, at least as I perceive it, that the salvation that lies in wealth may be illusory. He used this expression, the salvation that lies in wealth.

I would like to suggest that we may have reached the point where also the salvation that lies in education may becoming illusory, and that then will present some very, very grave and serious questions concerning the extent and the fashion with which we make education accessible to different populations.

In short, that I think almost quasi-religious movement in this country, or at least the social movement in this country which created our educational system, has had attached to it the notion that somehow or other an education is the salvation of man, his way to attain freedom and fulfillment and integrity and all sorts of things, and that may be a doctrine which has now had enough experience to be really gravely questioned.

And I think our younger generation is questioning it. So I see in the notion that self-liquidating ideals extend to the field of education, some really serious and very grave policy questions.

Dr. **Bell.** Dr. Brown?

Dr. **Brown.** Mr. Chairman, there is one American ideal which has been touched upon by Dr. Boorstin and by Dr. Spilhaus, and that is the confident belief that somehow inherently there is always something good about growth, that growth is basically good, that when one's growth ceases that somehow or other we are stagnant.

Now, I am referring here not just to population, although that certainly is a component. An equally important component, however, is the growth in what it takes, in our own mind, to support an individual within the framework of our own society, our own culture.

Quite clearly, if the average person requires the transportation of 5,000 ton-miles of freight every year to support him, or if he himself is going to travel between cities 10,000 miles per year on the average, more space is required for him than for an individual who travels very little between cities, who leads a less abundant existence from the point of view of personal possessions.

And I raise the question, how great will our needs become, because the greater our needs become, the more crowded we become, in effect, because we interact with each other more. Quite clearly the privilege of having one ton of steel wrapped around your body, traveling 80 miles an hour, is going to require more space, than the individual who goes from one place to another walking at 2 miles per hour.

Quite clearly, today—I mentioned that about a half a ton of steel goes into the support of an individual each year. This is proven on a per capita basis. Already we are up to something like 7½ tons of stone produced each year and put in place, someplace for every single individual.

During the course of a single human lifetime, something like 500 tons of stone are put in place, and in order to move that about or in order to get it into place and support it, something like 2,500 tons of coal—or its equivalent in oil, Mr. Hechler—must be injected into the system.

Today we consume energy at the rate of consuming about 10 tons of coal per person per year, but that is going up at the rate of 15 percent a decade, on a per capita basis, and there is no slightest sign that it is going to level off. And what goes into a system eventually has to go out of that system, too, be disposed of or handled in some way.

So I suggest that the idea of growth is an idea that we have got to get out of, because it directly contradicts virtually every other single idea which Mr. Boorstin has discussed. I suggest, sir, that we are probably going to find ourselves in a position in the not too distant future where chambers of commerce will have to become clandestine organizations.

Dr. Bell. Dr. Boorstin?

Dr. Boorstin. I am grateful to Dr. Brown and Dr. Noyes for their suggestions and their extensions, all of which I would endorse, and I thank them for mentioning things I wouldn't have thought of, and also for stating them better.

I might make a couple of comments, however, on the implication of this, and I think education might be an illustration of it. I think that in speaking of the dangers of the growth concept, we may be putting our finger on a kind of substitute for values, which has been very easy for us to have, because growth is a concept which seems to be a value, but doesn't need to have any content: and therefore, everybody can be in favor of it and then later settle the question of growth toward what end or how and at what price and so on.

Now, that has been a very popular idea from the beginning, which again has been invited by the emptiness of the continent and the vastness of the continent. I suggest that among our various foibles as a Nation, one of our tendencies is to take an institution that is failing in what it is doing, and salve our consciences by saying it can do everything.

And this has been one of our tendencies in our attitude toward educational institutions, that people say the educational institution is not quite good enough, you know, it is not doing its job in research and teaching. Well, their answer often is not to make it better in research and teaching. Rather, too often they try to make it into a settlement house, a training school for revolutionary tactics, a de-acculturation center, and so on and so on and so on.

And I think that one of the problems is our tendency to fail to differentiate our thinking about different kinds of institutions. Now, the university cannot be everything. That is one of the few things it seems to me we ought to be able to agree on. It can't be everything. And yet that is the kind of assignment we are giving it.

And I think therefore that if one were trying to think of the functions that might be performed by this learned, distinguished panel, which is a permanent fixture of this committee, and by this enlightened committee of the House, there might be two assignments. First, to prepare us for the unexpected, and second, to moderate our expectations.

Both of these functions, I think, are necessary in the present state of the country, and especially when people are so willing to give credit for high ideals and clear aspirations to anybody who is against any existing institution. I think that the question of where we are going is not self-defining, and a gasoline can doesn't give us the answer.

Therefore, one important role, if we can do nothing else in thinking about these problems, is to insist that we cannot expect every one of our institutions to perform all of our functions and that what we are really talking about at every point is the price that we have to pay. That is the question that I think we have to be willing to face.

Dr. Bell. I know a number of the members of the panel want to make some comments, but since we will be discussing education this afternoon, I would ask them to hold it, and we can tie it into that.

We do have an observation which has been prepared by one of our foreign guests, Dr. Osmo Wiio, professor of organization theory and personnel management, School of Business Administration, Helsinki University. I would like to have him, in effect, close this session with his own remarks on the problems of technology and values. Dr. Wiio?

STATEMENT OF DR. OSMO ANTERO WIIO, PROFESSOR OF ORGANIZATION THEORY AND PERSONNEL MANAGEMENT, SCHOOL OF BUSINESS ADMINISTRATION, HELSINKI UNIVERSITY, AND CONSULTANT, SITRA FUND, HELSINKI, FINLAND

Dr. Wiio. Mr. Chairman, ladies and gentlemen, it is a great honor indeed to come here before such a distinguished gathering to speak about managing information and knowledge here in the United States.

It makes me feel like the proverbial salesman selling iceboxes to Eskimos. I realize, however, that the analogy is not quite fitting in this case, even if we don't have ice bears walking on the streets of Helsinki.

My contribution in this connection can only be a possible different view based on the experiences in a small European nation. In some respects the United States is regarded as the spearhead of progress in the world. And we are trying our best to follow, some 20 years after.

In some respects, I am afraid, the United States is regarded as an example of what happens if you are naughty. Coming after you helps us to avoid some of the mistakes made here.

Technology is rapidly changing human life throughout the whole world—directly or indirectly. However, for the large majority of mankind technological change is a remote thing; it does not touch upon everyday life. This is very much true in the developing countries, but even in the most advanced industrial societies millions of families live in conditions which are not much different from what they were some hundred years ago. When people initially come into contact with modern technology, the technology usually takes one or all of the following forms: communications, industrialized work methods, and military technology.

At present, perhaps, the real vanguards of modern technology are mass media and communications systems. In underdeveloped regions a radio or television receiver literally opens a window into a new world and can start change in a society which has been stable for centuries. There are many studies which confirm this, one a study about the coming of television into the arctic Lapland of Finland. The study showed that the new medium made it possible for the Lapps to compare their living with conditions in other parts of the country; the comparison caused dissatisfaction and pressure for change.

The somewhat blind and naive belief in the great power of the mass media has been replaced by a more sophisticated opinion based on communications research. The effects of mass media are gradual and generally small; in a modern society the audience has developed an automatic protection against an overload of information. However, the effects of the mass media may be significantly greater in a primitive society where there is little psychological protection against persuasion and propaganda through mass media. It may seem paradoxical but the more an individual is exposed to mass media messages the more difficult it may be to use persuasion to change his attitudes and behavior.

In recent years there has been talk about direct radio and television transmissions from satellites orbiting above foreign countries. This innovation would mean, for example, that an American television show or a Russian film could be seen in India and the Indian authorities could not do anything about it. As a result, many representatives from small or developing countries have expressed concern about these programs. Some of their concern is political, some commercial. They fear that the system would be used for political propaganda or commercial advertisement in a society which would be vulnerable to such persuasion. The fear is at least partly justified because even nonpersuasive daily television programs from a more advanced society would bring with them value systems which may not fit less developed societies. There have already been student revolts against mass-consumption ideology in preindustrial countries—at least 50 years too early. On the other hand new values through communications might start changes toward the improvement of stagnant societies.

My guess is that any attempt on the part of one country to unilaterally decide the program content of direct broadcast transmissions would poison relations between the transmitting and receiving country. Therefore, I would recommend that an international agreement be worked out to handle this new problem.

Mass communications are also of major importance in advanced industrial societies. Omitting work and sleep they consume the largest part of our daily life—anywhere from 1 to 5 hours. Although the direct effects of the mass media in a modern society are smaller than usually suspected, prolonged exposure to them has an effect in the formation of values, attitudes, opinion, and behavior. Communications in the broad sense of the word—communication of ideas and people—have changed the daily life of modern man perhaps more than any other technological change.

Marshall McLuhan has coined the phrase "the medium is the message." Much of our communication consumption is really consumption for its own sake regardless of the content of the message. Communication is the exchange of information and information is supposed—by definition—to decrease uncertainty. Very often there is very little information passed through the mass media—especially television. Communication through the media developed by technology has become a value in itself: people enjoy vicarious experiences instead of taking part—or participating, as the modern phrase goes. We are also mostly worried about how the messages reach the audiences but we seldom worry—or study—how the messages are understood and what kind of information should be communicated.

In many ways technology has lost its function as a tool and has become a value in itself: industry produces things that nobody really needs, gadgets are bought that serve no useful purpose, and technological achievements are worshipped regardless of their practicality. This has in some cases led to what I call the "black box fallacy." The black box is one of the most useful inventions of all time; it can be anything from a newsstand to a world government. You can take a black box, write NASA on it, feed in $26 billion and out comes a trip to the moon. This is all fine and useful but the employment of black boxes can be carried too far. You can have, for example, one box symbolizing a computer and another a factory. If you are able to simulate the operation of the factory with the computer so that the inputs and outputs of both boxes are the same you may think that the boxes operate similarly or that the contents have to be similar as well. That may or may not be the case. You really cannot tell because in an open system such as human organizations there are many ways to reach the same goal. This is, of course, a very simple example but it is quite common to draw far-reaching conclusions about black boxes and to try to mold social or individual human behavior to fit the "behavior" of the black box. The map is never the original landscape, the word is not the object, the blueprint is not the machine. Norbert Weiner was one of the first to construct cybernetic models of human behavior and human society, but he was also one of the first to warn of the dangers of drawing such analogies between computers and men.

It is interesting to note that technology has been widely attacked by the youthful dissenters both in the United States and Europe. It is not coincidence that automobiles have been the main targets in street fights and that computers have been damaged. Even here technology has lost its value as a tool and become a value in itself: not only a symbol.

It is almost an axiom now that technology is the main cause of change in the modern world. However, much of the change is haphazard and beyond the control of political decisionmakers. An innocent-looking device is invented and in the space of 10 to 20 years it brings about more change in the world than any event short of a nuclear war. By inventing the transistor Shockley, Brattain and Bardeen may have shaped the future more than any statesman and by inventing penicillin, Fleming saved more lives than were lost in the two world wars combined. Often the invention is stumbled upon accidentally or it is developed as a solution for a minor problem: Gabor invented holography to make sharper pictures in electronic microscopes and now the system seems to have made a major contribution and to have many future applications in such fields as communications and data retrieval. So unless we forbid new inventions there is not much we can do about these "random" discoveries which change our lives. We can plan the future but at best we can only devise a "surprise-free" projection, as Herman Kahn writes.

If one listens to the critics of technology, then technology is to blame for everything bad and dangerous, from pollution to the atom bomb. Some of the criticism is justified but one should also remember that the modern standard of living is only possible in an industrial or postindustrial society. We, who enjoy this living standard, take for granted items like medical care, housing, an adequate diet, old age protection and so on, all benefits which we owe, in large part, to technological developments. But even then one should realize that technology and the resultant economic growth are only tools to make a better living for us—human beings. You cannot have eternal economic growth nor is it necessary. According to Daniel Bell this will be the philosophy of a postindustrial society.

Not all criticism of technology concerns obvious problems such as pollution and mass consumption. There is also concern about more subtle effects: the loss from individuality and the dangers of computer data systems for the individual. So far these problems are, happily, mostly American problems. First of all computer technology here is far ahead of that of any other country and such computer systems are already feasible. On the other hand, in most European countries the authorities have traditionally had much more information about their citizens than in the United States. A European is usually obliged to register his address and changes of address and to furnish a large amount of information each year in his report of taxable income. In many other ways the authorities gather information about citizens and this has not yet been considered any great danger for individual freedom in European countries although it is realized that, with modern computers, such information could be used maliciously. Therefore there should be adequate social safeguards and controls to prevent misuse of information. It must be left to each individual society to decide what it considers to be misuse. In addition every individual should have access to information concerning himself and an opportunity to try to correct any errors.

In most European industrial societies one aspect of technological development is becoming more and more obvious: automation with all its implications. One of the greatest effects of automation has been on education, which is rapidly changing in most European countries. The change is deep and runs from elementary education to the universities. The obsolescence caused by rapid technological change is changing the concept of learning in many ways. It may no longer be wise to train young people for specific jobs and professions which may not exist when the training is finished. It may be better to give the student a good basic knowledge and then to leave his vocational training to employers. Also the whole question of adult education is under fresh consideration: a large number of people have to be retrained into new jobs each year when their old jobs disappear because of automation. The apparent fact that changes in educational systems usually come about 20 years too late is a serious problem in most modern societies.

The industrial society with its economic growth and mass consumption has been a necessary phase to channel human resources into the development of a welfare state. However, one must also admit that the growth has developed a materialistic value system which is unnecessary after a certain level of well-being has been reached. The younger generations are already rapidly developing a new value system in most modern industrial societies. I conducted a survey on expectations for the future among students of the School of Business Administration where I teach. I asked the students to predict what they think Finland will be like in the year 2000. The most frequent answer by far was: polluted. Yet Finland is a country where pollution is a minor problem compared with some other countries in Europe. It makes me a little sad to think that in years to come I may be remembered as one of the generation which polluted the country instead of being remembered as one of the builders of its welfare.

Dr. BELL. Thank you very much, Dr. Wiio. We will now adjourn for lunch and come back at 2 p.m.

(Whereupon the luncheon recess was taken.)

AFTERNOON SESSION

Dr. BELL. We have a rather full program this afternoon, and I would like to begin as soon as we can. And since we have three papers I would like to allow almost a full hour to each one, taking a short break somewhere about after the second one. We have the first paper for discussion, the one by Mr. Paul Armer of Stanford University. Those of you who have seen the papers must admit that coming from a technologist that it has a sense of almost the Toynbeen Sweep, since it is called, "The Individual: His Privacy, Self-Image and Obsolescence."

Somewhere in this paper Mr. Armer remarks that even though he is a specialist now in computer science, he was trained in meteorology. To paraphrase a statement which is now current in some aspects of the New Left, I don't think you need a weatherman to know which way the wind will be blowing.

Mr. Armer.

STATEMENT OF PAUL ARMER, DIRECTOR, COMPUTATION CENTER, STANFORD UNIVERSITY, CALIFORNIA

Mr. **Armer.** Thank you. It is a fairly common topic of conversation among people in the computer field to say to one another, how are we going to get the attention of the establishment. I think that which has gone on in this room for the last day and a half is pretty much another example of our failure to get the attention of the establishment. I am about to adopt another strategy, taking a lesson from the students at the university these days, namely, to become insulting.

I note that with respect to the establishment just about everyone in the back row is not here.

Dr. **Bell.** In fairness to our committee members, I must tell you that they are now voting on the veto of Mr. Nixon. Mr. Nixon vetoed the HEW bill. The two dots on the clock behind you up there indicate there is a rollcall on the House floor, and usually many of them leave for that reason, so one has to be fair to friends and establishment enemies alike.

Mr. **Armer.** I appreciate that these gentlemen are exceedingly busy. I don't know how they do their job. It seems to me we are involved here in the process of technological assessment, so I would like to briefly talk about technology.

So far we have heard very little about it. I would then like to turn briefly to two topics, two problems, first of all privacy, and then technological obsolescence.

Yesterday it was said several times that it wasn't enough just to state a problem. That one must also present a solution. And I believe it is a common human trait to expect that every statement of the problem be followed somehow by a prescription of how to solve it. Things unfortunately are usually not quite that simple. And in fact, not all problems necessarily have solutions, at least in some sense.

I am reminded of a priest friend remarking to me one time that he was lamenting the fact that people had this notion, that all problems had solutions. His example was the man who came to him and said, Father, I love my wife, but my mistress is pregnant. You know, people somehow expected him in this instance to come up with a solution which was going to make everyone happy. And those solutions don't always exist.

Now, it seems to me that a thorough discussion of a problem is a prerequisite to finding a solution, and for complex problems sometimes the next item on the agenda is just how to organize to solve a problem. With respect to the problem of privacy, it seems to me that we have discussed enough and it is time to set up the problem-solving mechanism. Like the problem presented to my priest friend, I don't think there is a solution that will make everyone happy, for there are indeed conflicting goals.

And the questions to a large extent are political, not just technical.

With respect to the problems of technological obsolescence, I doubt if it has yet been discussed enough, in the sense that people have to realize that a problem is becoming rather severe before they marshal forces to solve it. In a sense, you might view my behavior as shouting the house is on fire. But obviously before anything is done about it, a lot more people are going to have to come to that same conclusion.

To that problem, I will at least in some sense propose the form of a solution, one that costs something like $30 billion a year. How does that grab you? It is a solution that in some sense is self-defeating since it makes the underlying problem, namely, the pace of change, worse.

In discussing this problem with students, more and more I am asked, but can't we slow down the pace of change. And that's yet another problem.

One of the difficulties with that problem as Toynbee has pointed out, is that there is a basic incompatibility between global technology and local sovereignty. He points out that nationalism is by far the most powerful of all current religions. Nonetheless, I believe that this is the time that we address the problem of how we might slow down the pace of change, if we wish to do so. What I am going to say may not only be somewhat insulting, but also depressing to many of you. You may feel that I am damning you because you are not young, and because you are not computer scientists. I am sorry if it comes out that way. That is really not my intent. But among the problems I am trying to point out to you is that our problem-solving mechanism is in trouble. We are here to discuss problems associated with computers and communications, but very few people who are professionals in that field have so far even been involved in the discussion.

I submit that that is the reason so little has been said about computers and communications. I don't mean to suggest that this session should have been nominated by technicians in the field, but I do object to the balance that we have seen this morning. I should like to congratulate Mr. Chief Justice Warren on a keynote speech which was inspiring, interesting, and relevant, but if I may be very impertinent and ungracious I have found much of what has been said in this room so far interesting, but largely irrelevant to the topic that I thought we were here to discuss.

And with that bit of very atrocious grantsmanship, let me turn to computers and communications.

The first observation that I want to make is that the distinction between computers and communications is becoming very fuzzy. We used to think of a computer as being in one room, serving one user at a time. These days a computer is a system sometimes serving several hundred people simultaneously. Maybe connected over to several thousand terminals over a large area.

Approaching this fuzzy distinction between the two technologies from the communications side, if we look at modern sophisticated communications systems, they really look like and are computers.

The next point I want to make is that the technology in computers and communications is changing rather rapidly. Herman Kahn had a graph yesterday of how computer power has changed by like 12 orders of magnitude in—I guess it was the last 30 years, he had on his chart.

I like to make the analogy with the field of transportation, where the last order of magnitude in speed for the jet was set to something like 50 years for us to achieve. An order of magnitude beyond that was indeed achieved by the astronauts in going to the moon, but as far as earth-bound travel is concerned, we are really approaching a reasonable limit.

But the speed of computers has been changing the order of magnitude in the electronic organization of the machines at something like once every 4 years. The speeds of the mechanical computers of the 1940's were measured in seconds, whereas the speeds of today's machines are measured in nanoseconds, a difference by a factor of ten to the ninth.

A nanosecond is to a second as 1 second is to 30 years.

Most important of all is what has been happening to the cost. The cost of raw computing power has been declining by an order of magnitude something like every 4 years. Now the cost of the raw computing power isn't the only important variable because there are other costs associated with using a computer, getting the data in and out. We take an overall look at these costs, and the recent Stanford Research Institute Report prepared for the FCC, they predicted that the cost of doing a fixed task would decline at about 25 percent per year for the next decade.

It is a fairly common occurrence in the computer field to find ads for new products which promise a factor of declining cost, and recently California computerized our disk driver works twice as fast, for half as much. That was a factor of four in capability.

Suppose that the cost of automobiles or the cost of housing dropped by just half this year? I think there would obviously be a considerable impact upon society. But this is the kind of change which is taking place in the economics of the computer field. If we turn from computers to technology, you might expect that the distinction, since it is becoming fuzzy, would mean that communications technology has been going on at much the same rate. Not so. The previous SRI Report projects only a 2 percent per year decrease in cost of communications. I would conjecture that a major reason for this is that the forces of the marketplace just don't apply in the field of communications. The computers of the 1950's were built of vacuum tubes. If I were to say that none of these machines were in use today, someone might find one or two and prove me wrong, but I think the number is very small. In fact, in the computer field we are now entering our fourth generation of hardware, yet the telephone industry in some localities as the people in New York are rather painfully aware still uses equipment installed in the 1920's and doesn't plan on completing the changeover in electronic systems until nearly the turn of the century.

There are some encouraging signs, especially the recent rulings of the FCC which tend to introduce competition into the communications market. For my point of view, these rulings have come late and don't go nearly far enough, but they apply to direction of movement and I hope that future appointments to the FCC do not reverse it. I was recently asked by a magazine to predict who would be the most important man in the computer industry in the 1970's. My answer was, "The next appointee to the FCC."

Now, let me turn from technology to the assessment for the moment and talk briefly about privacy. My focus will be on the computer aspects, not the surveillance, wiretapping sort of things.

I will also skip over my prepared remarks in which I gave a brief discussion of the problem, and talk about what I think is a key issue with respect to privacy; namely, that like motherhood, it is not an unassailable topic. There are so many problems associated with it.

In this, trouble arises out of the conflicts between an individual's right to privacy, and society's need to know, society's right of discovery. By this I mean the belief that the society has a right to know anything that can be known or discovered about what goes on in this universe, and man is part of the universe.

I think it can be said that the common good cannot be realized in a society which consists only of private entities. It requires some renunciations of the rights of personal and corporate privacy. There is also a conflict between the individual's right to privacy and the individual's pocketbook. Some of the proposals that have been made with respect to regulation of credit bureaus might mean that the cost of these credit bureaus would go up by a factor of two or a factor of three. Some of the procedures of such legislation seem to have a notion that, well, the credit bureaus will somehow pay for that. I suppose out of their profits. I think that's nonsense. They can't stay in business, unless they pass those costs along to the consumer, so if those things become law, the cost of credit is going to become more expensive.

I am not saying that I am against such regulations. I am not saying that I worship efficiency. Rather I want to make the point that privacy will cost money, and the choice will have to be made between those two conflicting goals.

You may also have gotten the impression from my comments that I worship the forces of the marketplace. Not so. At least, not blindly, for they just don't work in many areas. Third party effects, pollution, privacy, are areas in which they don't work, because the individual involved in the credit transaction is in a sense not a party to the total mechanism. The credit bureau is the seller and the credit grantor is the buyer.

What can be done about assuring individuals and organizations an appropriate level of privacy in the era of computer utilities? One of the problems as I have just pointed out is that somewhat like pollution, privacy lacks an organized constituency. I think things happen in this political world of ours because of pressures, but in general we find only a comparatively few Congressmen and Senators, plus a few isolated scholars and writers in the ACLU pleading the cause of privacy. Most of their presentations tend to be philosophical, as this one is, not in-depth studies.

One reason is that scholars and organizations interested in doing work on the problems of privacy have difficulty finding financial support. If one is interested in doing research on the problems of health and education in our country, he can look to HEW for possible support. If he is interested in privacy, he can look only to private foundations. Most respected study that has been done in the privacy field, out of which came Allen Weston's book, "Privacy and Freedom," was supported by a grant by the Carnegie Corp.

My own work in the privacy area was while I was at Rand, was largely supported by Rand Corp. funds, which can be generically thought of as similar in nature to foundation support.

In accepting the invitation to give the speech I agreed with the staff of the committee that I would discuss what I felt to be appropriate legislation with respect to privacy. In doing this, I reviewed my thoughts on this, looked at a large number of papers, various legislation which had been proposed, not only in the United States but in the United Kingdom and Canada, and several States, and I began to list various general provisions, such as requirements that all data banks be registered, or that the individual have access to his records, and that he be told every time some information was revealed to a third party. I then asked myself which of these are good. Well, in general, they are all good—good from the standpoint of privacy. But the problem is that there is a cost associated with each of these, and I do not know those costs. So I asked myself, how can I make a judgment about which of these is worth more than it costs?

I further believe that some of these costs are really not known by anyone at the moment, because they are obtainable only through experimentation. Consequently, I abandoned the idea of trying to give you my recommendations as to what regulations should be written into law. Now, if what I say is true, then the immediate problem is, as I mentioned in my opening remarks, how do we organize to determine what regulations should be adopted? I believe I know the form of that answer at least. And it has been proposed previously by others. A. R. Miller, for example, and Alan Weston. It is my belief that some organization in the executive branch of Government should be charged with concern for the problem of privacy, just as the Department of Defense is charged with providing for the common defense, and as HEW is charged with the problems of health and education. Don't misunderstand me, I am not proposing a Cabinet-level organization.

Now locating an organization within one of the existing agencies which is a major collector and user of data about corporations and people is a little bit like asking the goat to guard the cabbage patch, so for this reason Miller suggests that the FCC or some new independent agency be charged with this responsibility.

Another notion seems pertinent, just as there are committees in the Congress, as it is with defense and health education, there should also be committees or subcommittees in each House whose purview is privacy.

Now, what might such a privacy bureau do? Well, there are a number of things which are outlined in my paper. I won't go into them here. But I think it is important to realize that there is no right or proper or correct balance. The privacy bureau is needed to do the staff work for the political process to somehow strike a balance, but no one can be said to be right or proper or correct.

Before going on to another topic I want to emphasize that I am not saying that no regulations should be passed until we study the program further. We could study it today. For example, the Associated Credit Bureaus has endorsed Senator Proxmire's Fair Credit Reporting Act. Presumably they have evaluated it, in terms of the cost associated with implementing it and do not find them excessive.

I believe that piece of legislation should be passed. The only danger I can see in its passage is that we might become complacent, that somehow the problem will be taken care of. It has not. The bill doesn't go far enough in providing protection. But, on the other hand, the various costs associated with accepting it must be studied. I also don't want to leave with you the impression that little research has been done so far. Two years ago at Rand my research association turned out an annotated bibliography which contained something like 320 entries. And that was over 2 years ago. Much has been done since then both in this country and in Canada. The many excellent ideas advanced need to be evaluated in greater depth than they have in general been evaluated so far.

In these discussions of privacy, I have not paraded before you the various horror stories that are often brought out. I think we have all heard enough of them, and are probably convinced that there does exist a substantial threat to privacy resulting from the unprecedented changes that are taking place in the technology and in the economics of computers and communications technology. Those changes I have paraded before you.

In closing the privacy portions of this talk, I would just like to quote briefly from Miller. Perhaps the most imperative need at this point in time is a substantial input of human resources to help solve the many privacy problems posed by the new technologies. That is what I think we need to get on with.

Turning now to technological obsolescence, which is a form of the impact of computers on employment, we often think of the impact on employment in the usual way of where the man loses his job because the job no longer exists, due to the installation of a computer or some new automated equipment or something of that sort. That's not what I'm talking about. What I'm talking about is, I think, much more subtle and less visible. But one which I believe has considerable impact for individuals, for society, and organization.

A recent magazine article cited a number of unpleasant horror stories, incidents in which managers have lost their jobs in mid or late career. The article concluded that a middle management union was a solution to the problem. It seems to me that solution focuses on the symptoms, rather than on the disease itself. Well then what is the disease? I would argue that there are three possible explanations for such incidents. The first is the one in which the job disappears because of a merger or some reorganization, and in this instance it is not related to the competence of the individual.

The second possible explanation is the Peter Principle. The Peter Principle states that individuals tend to rise in an organization until they reach their level of incompetence.

The third explanation is the one which I have immodestly dubbed the Paul Principle, since it goes along with the Peter Principle. And the Paul Principle states that individuals often become incompetent at a level at which they once performed quite adequately, but they become incompetent as a result of their becoming uneducated for the job.

Perhaps an example will explain what I have in mind. An individual who has risen in the company until he is responsible for all the data processing activities of a company. The demands of his management duties leave little time for actually working with the technology itself.

Over time his proficiency in the technology becomes less and less current, and after awhile he is less and less able to perform his job. Eventually he may be demoted, pressured to resign or even fired. I think you may recall Herman Kahn mentioning yesterday that the best paid people in the computer field were in an age bracket of about 30 to 35, and thereafter they tapered off.

I have seen many examples of this, not just in the computer field, but in all areas of human endeavor that involve significant amounts of science and technology, and I include the businessman here. The businessman's job these days does indeed involve science.

And it is not just confined to middle management, but it is also prevalent at the top and at the lower echelons. I have seen a number of executives who psychologically were in a bad way because they were aware that they were technically obsolescent, and that they were no longer in control of the organization they managed.

Let me put this another way. It used to be that an individual could go to school, take a job, learn through experience and do well until he reached retirement age, drawing on his later years so to speak on the intellectual capital he had coined in his early life. This is now difficult in many positions. Now, the pace of change is such that so much takes place in a period of time which is short compared to the life span of man that he becomes obsolete, his education becomes obsolete. We find companies terminating men of a given specialty at the same time they are hiring men in that specialty fresh out of school. We find companies restricting the number of older men that they will hire. We find companies in trouble because their management is obsolete. And as I mentioned, we find individuals psychologically disturbed because they know they are obsolete.

Now, in thinking about a solution to this particular problem, we obviously think of continuing education. We might think of two levels of such education. The lower level consisting of English classes, reading, attending short intensive courses, or continuing to hold down a job. At the higher level, one would not attempt to hold down a job, but would devote full time to further education for a significant period, say, 6 months or 2 years. It seems to me that for many positions, the part-time level is becoming less and less adequate. The individual uses up his intellectual capital faster than he can replenish it. Now, if I were to suggest to someone in mid-career that he take off a year in order to replenish his intellectual capital, his response is apt to be, I have got a capital problem if I do that, but it is not intellectual, it involves dollars. If we are going to have a continuing education, that involves this upper level, and I believe we are going to need it, I think we need it to some extent today. Then the tuition cost or a small part of the cost is the major problem in cost associated with the fact that individual has to forgo income while he is not working.

Now the academic world in some sense has had a system of this kind for some time. A system of this kind, sabbatical leave situation. It is part of their culture and employers accept it as a cost of doing business. The academic world I might point out also has its equivalent of the middle management union. It is called tenure. But that is another problem.

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Now, can we transfer this sabbatical mechanism from the academic community or industry? I suspect not, although there are a few large firms who do support some activity along the lines that I have been talking about. But the private sector is in general very competitive, compared to the academic world, and I just don't see this being transferred to industry because we will find that some companies who set up down the street from a company that does grant sabbaticals, hires the people just after they have been renewed at a slight increase in salary, and therefore is able to compete to produce at a much lower cost than the company which is granting sabbaticals.

There are problems other than financing such a system as I have just supposed, because the mechanics aren't at all obvious to me, and motivation will be a major problem. Since I don't see how this can be done on an industry basis, then it seems to me we need a much broader based system, for example, something in the nature of the Social Security System.

I would like to take a brief look at what this might cost and develop that $30 billion figure I gave you in my introduction. If we assume that 5 percent of the labor force, and that is probably the number which is hardest to guess in this cost estimate, but let's assume 5 percent is involved in any one point in time, further assume that the cost of educating that person in terms of tuition and his foregoing income is the order of $8,000 per person per year, and assuming a labor force of 70 million, we then get to my $30 billion figure. That looks pretty expensive. Can we afford it?

Well, I suppose we could if we wanted to. There are obviously many other competing projects for that money. It is about 3 percent of our gross national product. It is less than half of our defense budget. It is about the same as our annual increase in productivity. If you are doing it, it is going to increase productivity. It is also more than we spend on higher education today, if we ignore the foregoing income cost of higher education.

It is also, ironically, I think, going to increase the pace of change. That's the very thing which makes the program necessary in the first place. So, in that sense, the program is self-defeating. We will have to run even faster in the future just to stay even.

Now, this problem carries over from the individual it seems to me, to institutions. Because institution adaptation is very much geared to individual adaptation. If you will excuse the expression the old guard frequently stays on until retirement, especially in our public institutions. There are other hindrances to institutional adaptation; they often have a great deal of built-in inertia. Large organizations are difficult to change. Our forefathers deliberately built a good deal of inertia into our system of government. They were appropriate to survival at the time.

Let me bring the matter a bit closer to home. The computer industry now claims to be the third largest industry in our economy, starting from a dead start less than 20 years ago. Some industry prophets predict that it will pass the automotive industry and become No. 1 by 1970. Others aren't as optimistic on time but are just as sure that it will happen. I have argued that computers in communications are having and will have a fantastic impact on our society. If this is indeed the case, then one would hope that one would find expertise in computer information science well represented in the establishment. Yet as

I have scanned the distinguished roster of the panel on science and technology, I do not find a single person representative of the computer and information sciences. And I would be most pleasantly surprised if any of the members of the committee on Science and Aeronautics had more than a passing acquaintance with computers and information science. Some of the panelists may have considerable experience using computers in their own disciplines, but from my biased point of view that is like the difference between being a pilot and an aeronautical engineer.

The Natural Academy of Science does have a computer scientist, Professor Rottenberg, of Harvard, as chairman of computer science and engineering board. But he is not a member of the academy. I presume the reason is that he is too young.

I am not suggesting that the academy suddenly admit a number of 30-year-old computer scientists. We discussed yesterday the concept of wisdom as distinct from knowledge. We didn't arrive at any disagreement as to how wisdom was obtained, but I think we will all agree that it is somehow correlated with experience and age. Rather, I am pointing out that if we had had in the past a real program of continuing education, there might be some people around to appoint to the academy who might say, have taken a Ph. D. in physics at age 25 and a Ph. D. in computer science at age 45, and they might be appropriate appointees to the academy today.

As Professor Bell pointed out, my own formal education was in meteorology, not computer science.

Let me briefly talk about man's self-image, because it seems to me that computers, communications, rapid technological change in general are all striking serious blows at individual psyches. Certainly those who epitomize either the Peter Principle or the Paul Principle feel most insecure in lack of feeling of accomplishment and worthiness. The computer might be thought of as just one more step which began with Copernicus telling us we are not the center of the universe, Darwin raising doubts about the divine creation, and Freud saying that we are not completely rational. The concept of an all-powerful, infinitely fast computer is a real threat to man's self-image. It appears to many as something which competes in an area of human endeavor—his intelligence—which he associates most closely with his own humanity. I believe that most people do not have much of a problem making the intellectual leap from the Fourth of July rocket to a trip to the moon. They are fantastically impressed, but somehow they have a feeling that they understand the process. But the intellectual leap from the adding machine or desk calculator to the computer which can carry on a conversation in English with the user is one which is totally beyond most men's comprehension. There are many computer specialists who believe that it takes at least a week of intensive instruction to teach computer concepts to executives. Here we have an audience with way above average intelligence and education. No wonder many lesser individuals feel that it is impossible to learn what computers are all about. And if the individual believes that he can't learn it, then he will not be able to do so.

Men feel they just can't cope with the rapidly changing environment in which they live, or they may just decide not to cope, as many of the younger generation are doing when they head for the rural areas to form their communes. This fear of a world that is changing so rapidly that one is unable to function well in his job or in his role as a citizen is not confined just to the less educated. Many of the students who are heading for the country are well educated. I believe that the Paul Principle is operating at the highest levels of industry, science, and government. And, in fact, I wish I were able to take a secret poll of the individuals in this room, as to whether or not they felt they were an example to some extent of the Paul Principle. I bet that at least a third, possibly a half of you would secretly admit to it. I know I would.

Thank you very much.

Dr. BELL. Thank you, Mr. Armer.

It may well be—I can't speak for the panel at all, but I did notice one peculiar thing, which is that all the younger people today have beards, and all the older people today don't. This is particularly true, as I say, on the panel here, that the younger members have beards and the older ones on the panel here don't. And maybe by the time you shave off the beard you will be old enough to become a member of the academy.

So all I am suggesting is, you see, that given the rapid rate of obsolescence the only thing we can do is become philosophers and becoming philosophers, we are able to contemplate our experience and try to become wise. We are open for some discussion.

I was told that this is quite true. About 70 years ago when the young men came to the University of California at Berkeley, the parents got very upset because the first thing they did when they went there was to shave off their beards. That was part of the revolt at the time of the young intellectuals.

(Mr. Amer's prepared statement is as follows:)

THE INDIVIDUAL: HIS PRIVACY, SELF-IMAGE, AND OBSOLESCENCE

(By Paul Armer)

COMPUTER AND COMMUNICATIONS TECHNOLOGY

We are engaged in this conference in the process of technological assessment. Consequently, I should first like to talk about the technology of computers and communications. I'm more comfortable talking about that topic since I am a computer technologist and not a lawyer, nor a political scientist nor a psychiatrist nor a psychologist nor a sociologist nor an economist, nor an educator. Of course, the list of things I'm not is endless, but the disciplines I have just enumerated will all be impinged upon in what I have to say today.

The first observation that I want to make is that the distinction between computers and communications is becoming fuzzy. Professor Anthony G. Oettinger of Harvard has proposed that we recognize this by combining the two words into "compunications". I have trouble pronouncing it but I agree entirely with the idea. It used to be the case that all computers were physically confined to one room and serviced one user at a time. Today a computer system may have several hundred or even several thousand terimnals, spread over thousands of miles, connected to it over communication lines. The various users may wish to send messages to one another via the computer system—in fact, the major purpose may be the interchange of messages. An airline reservation system is an example of this. Approaching this fuzzy distinction between computers and communications from the communications side, we observe that modern sophisticated communication systems are, in reality, computers.

To make my next point, I'd like to use an analogy originally put forward by Richard Hamming of Bell Labs. (1) When things are changing rapidly, we find that the concept of "an order of magnitude" or a "factor of ten" is a convenient measure of that change. For example, we can travel by foot at about 4 miles per hour, by auto at 40 miles per hour, and by jet aircraft at something more than 400 miles per hour. Each mode differs from its predecessor by an order of magnitude—a factor of ten. The capability of getting around at 40 miles per hour has profoundly affected our way of life, and jet travel has shrunk our world immeasurably.

Contrast the pace of these changes with what has been occurring in the computer field. The last order of magnitude change in transportation speed for the jet set took about 50 years for us to achieve, and while another factor of ten may be but 10–15 years in the making, another order of magnitude beyond that, at least for earthbound travel, is probably infeasible. On its trip to and from the moon, Apollo 11 averaged less than 4000 miles per hour. But the speed of the electronic portions of computers (not the mechanical portions) has been increasing by an order of magnitude about every four years, and it looks like that pace will continue at nearly that rate of change for awhile, despite the limitations of the speed of light. The speeds of the mechanical computers of the 1940's were measured in seconds whereas the internal speeds of today's computers are measured in nanoseconds, where a nanosecond is one billionth of a second. One differs from the other by nine orders of magnitude. Light travels 186,000 miles per second but only about one foot per nanosecond. A nanosecond is to one second as a second is to thirty years.

Size (again I'm talking about the electronic portion of the computer) decreased by an order of magnitude in the last ten years, and will probably decline by three orders of magnitude during the next decade. The details of today's computers are not visible to the naked eye—the details of the computer of the future will not be visible in an optical microscope, since electron microscope techniques will have been used in their fabrication.

Most important, the cost of raw computing power has declined by an order of magnitude every four years, and this trend looks like it will hold for awhile. The amount of computing power in the U.S. has been expanding by an order of magnitude in something less than four years.

And there is another most important trend taking place in the computer field; namely, the introduction of time sharing where many small remote terminals, in the form of a typewriter or teletypewriter, are connected to a single large computer over communication lines. Because of the high ratio of computer speed to terminal speed, it appears to the user at the terminal that he has the complete attention of the computer. Thus computing power is being distributed in much the same way as electrical power and telephone service.

A moment ago I talked about the way the cost of raw computing power was declining. Many other costs are associated with using a computer—the costs of the mechanical devices for getting information in and out of the computer for one thing. Taking a larger view of what's happening to costs, an SRI report (2) prepared for the FCC recently predicted the cost of doing a fixed computer task would decline at about 25% per year for the next decade.

It's a common occurrence in the computer field for newly announced products to be at least twice as cost effective as their predecessors. For example, a recent CalComp ad stated "Our disk drives work twice as fast. For about half as much." (3) Suppose that the cost of automobiles or housing dropped by half this year? There would obviously be a considerable impact on society as a result. But this sort of change in economics is taking place in the computer field. It would be very surprising if such rapid changes were not profoundly affecting society.

Let me now turn from computers to communications technology. I stated earlier that the distinction between computers and communications is becoming blurred so one might suspect that similar changes were taking place in communications as have taken place in computers. Not so. The previously cited SRI report projects only a 2% per year decrease in cost for communications in the next decade while saying that the costs have been relatively constant in the past. I would conjecture that the reason for this discrepancy is that the forces of the marketplace just don't apply to the field of communications. The computers of the 1950's were built of vacuum tubes. If I were to say that none of those tube machines are in use today, someone might find one or two or half a dozen still working and prove me wrong—but the number is very small. In fact, the field is now entering the third generation based on transistor technology. (Counting the tube generation, this makes it the fourth generation in 20 years.) Yet the telephone industry in some localities still uses equipment installed in the 1920's and doesn't plan on completing the changeover to electronic switching systems until nearly the turn of the century.

There are some encouraging signs, especially the recent rulings of the FCC which tend to introduce a little competition into the communications marketplace. From my somewhat biased point of view these rulings come very late and don't go nearly far enough. But I applaud the direction of movement and hope that future appointments to the FCC don't reverse it.

On the technological front, communications satellites hold great promise for cost reductions. And cable TV is apt to have a profound impact on communications in the broadest meaning of that word, with a concomitant impact on society. The television aspects are trivial compared to the communications aspects.

Privacy

Let me now turn from the technology to the assessment. I could spend all my allotted time talking to you about the positive things that can be said about the impact of computers on society; how they have contributed to a rising standard of living, enabled us to get to the moon, helped to cope with the problem of increasing complexity in our social organizations, contributed to better health and education, etc. But those areas do not represent problems for which some actions need to be taken. So I'll be talking about the negative aspects of the impact of computers on society. But please don't forget all the important positive affects.

My focus will be on the individual, his privacy, obsolescence and self-image. I will not address the issue of the impact of computers and automation on employment in the usual way that topic is thought of, since it has been covered by previous speakers. My discussion of obsolescence is, however, a variation on that theme.

I'd like to first take up the privacy question—I'll be discussing it in the context of the computer and not with respect to wire-tapping, psychological testing, private investigators, etc.

As we go through life we generate a fantastic stream of information about ourselves and our activities. Most of that information is never recorded: e.g., most of our cash financial transactions, what we ate for dinner last night or what time we went to bed. If you get an elecrocardiogram even once a year, the sampling rate is like four out of a million. What information that is recorded and collected is widely dispersed and somewhat difficult and expensive to assemble. Information exists in small, widely dispersed puddles. But the advent of computer utilities and rapid changes in related technology are making it feasible to draw these puddles together into large pools of information. To put it another way, present systems give the individual a measure of privacy that he may lose in the computer utility era. Further, the rapidly changing economics are making it economically feasible to record in machine readable form much more information about our actions.

These pools of information are springing up all around us. The biggest one of all, the National Data Bank, is still in the discussion stage, thanks to concern about its impact on privacy. But many other pools are already in existence or, close at hand, on the federal level, and also at state and local government levels. In the private sector, the trend towards computerization and centralization of credit bureaus is viewed by many as a greater threat to privacy than the National Data Bank.

Most of the people who discuss privacy talk about it as though it were inviolable. Unfortunately, it isn't. Like motherhood, there are some problems associated with it. The trouble arises out of conflicts between the individual's right to privacy and society's right to discovery. By the latter I mean the belief that society has the right to know anything that may be known or discovered about any part of the universe—and man is part of the universe. Society aspires to know the universe.

Society has raised its level of aspirations in many ways—we look for improved efficiency in government, better law enforcement, and more rational programs in general. To do this, government needs more and better information about what is going on—information about people and organizations. Government also feels that it must have information to protect society from disorder and subversion. Thus, today, we read of proposals to consolidate government files and to establish national data banks of various types.

The common good cannot be realized in a society consisting only of private entities—it requires some renunciations of the rights of personal and corporate privacy.

There is also a conflict between the individual's right to privacy and his pocketbook. Some of the proposals being made with respect to the regulation of credit bureaus may double or triple the costs of such operations. The proposers of such regulations often seem to assume that the added costs will be borne by the credit bureaus, presumably out of their profits. That is nonsense. If the credit bureaus are to stay in business, the added costs must be passed along to the consumer—credit will become more expensive. I'm not saying that I'm against such regulations or that I worship efficiency. Rather, I want to make the point that privacy will cost money and a choice will have to be made between these two conflicting goals.

You may also have gotten the impression, from my comments about the telephone system, that I also worship the forces of the marketplace. I don't. At least not blindly, for they just don't work in many areas. Pollution is a prime example of a problem which arises because the costs to society of pollution do not enter into the market mechanism. Pollution is an example of so-called "externalitis" or "third-party" effects; an individual cannot exercise a choice in the marketplace as to the cleanliness of his air or water. Only government regulation, or the fear of it, can impose some measure of control on the problem.

This holds true for privacy as well. In credit bureaus, for example, the individual is a third party not involved in the market aspects at all. The seller of the information is the credit bureau; the buyer is the grantor of the credit.

I want to point out that the problem of privacy has been with us for a long time and has not been brought about by the computer. But the computer, by introducing orders of magnitude change into the economics of the situation, is bringing about significant qualitative changes. We might consider one aspect of this change as positive: the computer is focusing light on a situation of long standing, where reality is undoubtedly much worse than most people realize. As a result of the examination going on, some aspects of the problem may be improved.

What can be done about assuring individuals and organizations an appropriate level of privacy in the era of computer utilities? One of the problems with doing something about privacy is that it lacks, as do pollution and other social problems, an organized constituency. Things happen in this political world of ours because of pressures. But these pressures or forces must be focused to be effective. For this reason, there exist all kinds of trade associations, labor unions, etc. The force most difficult to focus, even though large, is that of the man on the street. Look at the difficulties associated with passage of laws related to consumer protection, automobile safety, meat inspection, truth in lending and gun control. The power of the populace, compared to that of the groups lobbying against such laws, has not been very great in the past.

All the forces of the marketplace are pushing us toward the cashless and checkless society—toward the computerization and centralization of data banks. In the cashless and checkless society, much of the information about our actions which goes unrecorded today, will be captured by the system and available in the system. Orders of magnitude changes in the economics of recording, collecting and processing of information about individuals are taking place. Counterbalancing political and social pressures are not effectively focused.

In general, we find only a few congressmen and senators, plus a few isolated scholars and writers and the ACLU pleading the cause of privacy. Most of their presentations tend to be philosophical in nature, as this one is, rather in-depth studies. One reason is that scholars and organizations interested in the problem are limited in the places to which they can look for financial support. If one is interested in doing research on the problems of health or education in our country, he can look to the Department of Health, Education and Welfare; but if he is interested in privacy, he can look only to private foundations. The most respected study on privacy which resulted in Alan F. Westin's book entitled "Privacy and Freedom" (4), was supported by a grant from the Carnegie Corporation.

The work that was done at the RAND Corporation (my former employer) resulted either from related work on military security or was supported by RAND Corporation funds, which can generically be thought of as similar in nature to foundation support. Very few studies of the problems of privacy have been explicitly supported by the executive branch of U.S. government.

In accepting the invitation to give this speech, I agreed with the staff of the committee that I would discuss what I felt to be appropriate legislation with respect to privacy. In an attempt to do so I reviewed my own thoughts, a large number of papers and all the proposed legislation I could get my hands on, not only U.S. originated but from the United Kingdom, Canada and several states. I began to list general provisions (e.g. requiring that all data banks be registered or that the individual have access to his own files and be told anytime the information is revealed to another party, ec.). Then I asked myself "which of these are good?" In general, they are all good. But the problem is that each has a cost associated with it. And I don't know those costs, so how can I make a judgment as to what is worth what it costs and what is not. I further believe that some of those costs are not really known by anyone since some of those costs will be obtained only by experimentation.

Consequently, I abandoned the idea of trying to give you my recommendations as what regulations should be written into legislation.

If what I say is true, then the immediate problem is how to organize ourselves in order to determine what regulations should be adopted. I believe I know at least the form of the answer as to how to organize ourselves. This answer has also been proposed by others. (For example, A. R. Miller.) (5)

It is my belief that some organization in the executive branch of the government should be charged with concern for the problem of privacy, just as the Department of Defense is charged with providing for the common defense and as HEW is charged with the problems of health and education. Don't misunderstand, I'm not proposing a cabinet level organization. Locating such an organization within an existing agency which is a major collector and user of data on people or corporations is "like asking the goat to guard the cabbage patch". For this reason, Miller suggests either the FCC or a new independent agency.

Another notion seems pertinent. Just as there are committees in the Congress concerned with defense, health and education, there should be a committee or subcommittee whose purview is privacy.

What might such a "privacy bureau" do? At a minimum, it might turn out an annual report on the state of privacy in the country, which would provide some illumination. But, more important, it should have staff to study the problem, to estimate costs and benefits and to draft legislation, just as HEW may draft legislation in the health area. And like the Public Health Service, it should have money for research grants and contracts and money for experimentation. Industry (e.g. the Credit Bureaus) might bear some of the experimentation costs. The privacy bureau should be charged with developing a register of data banks, both private and public. And possibly after some future date, no data banks should be permitted to exist without the privacy bureau's approval of their operations. It should attempt to assess the value of public data banks, including the National Data Bank and modifications thereof, while developing methods, procedures and technology to safeguard the information stored in such banks. The only way we can go about defining a balance between the individual's right to common privacy and the common good is through the political process. It is important to realize that there is no right or proper or correct balance. The privacy bureau is needed to do the staff work for the political process.

Before going to another topic, I want to be sure that I don't leave you with the impression that I feel that no regulations should be passed while the problem is studied further. For example, the Associated Credit Bureaus, Inc. has endorsed Senator Proxmire's Fair Credit Reporting Act. Presumably they have evaluated the costs associated with implementing its regulations and feel that they are not excessive. I believe that piece of legislation should be passed. The only danger I see in its passage would be complacency that the problem had been taken care of. The bill doesn't go far enough in providing protection, but on the other hand, the costs of extending it need to be studied.

Neither do I wish to give you the impression that little research has been done so far. Two years ago my research assistant at RAND turned out an annotated bibliography containing some 320 entries. (6) Much has been done since, both in this country and abroad, especially in Canada. But the many excellent ideas advanced need to be evaluated in greater depth than they have been so far.

I haven't paraded before you a number of horror stories citing invasions of privacy. I believe we've all heard enough of them and are convinced that there does exist a substantial threat to privacy resulting from the unprecedented changes taking place in computer and communications technology—which I have paraded before you.

I should like to end the privacy portion of my talk with a quotation from the previously cited article by Miller:

"Perhaps the most imperative need at this point in time is a substantial input of human resources to help solve the many privacy problems posed by the new technologies."

Technological Obsolescence

When we think of the impact of computers on employment, we usually think of the situation where the introduction of a computer or some technological change results in the fact that a given job no longer exists. This impact of technological change on employment is quite visible. But there is another form of impact, more subtle and much less visible. And one which, I believe, has very serious implications for individuals, organizations and society.

A recent magazine article (7) cited a number of unpleasant incidents in which middle managers in mid- or late-career suddenly found themselves fired or demoted. The article concluded that a middle-management union was the obvious answer to providing protection against the economic disaster for the individual inherent in such incidents.

To me, the union approach focuses on the symptoms rather than on the disease itself. What then is the disease? I would argue that there are three possible explanations for such incidents. The first is that the position disappears due to a merger or reorganization and is not related to the competence of the individual. The second possible explanation is the "Peter Principle" (8) which states that individuals will rise in an organization until they reach their level of incompetence. The third explanation is one which I have immodestly dubbed the "Paul Principle," since it goes hand in hand with the "Peter Principle". The Paul Principle states that "individuals often become, over time, uneducated and therefore incompetent at a level at which they once performed quite adequately."

Perhaps an example will help explain what I have in mind. Let me take it from the computer field, since its technology is changing very rapidly. Suppose an individual has risen in a company to where he is responsible for all computer and data processing activities in the company. The demands of his management duties leave little time for actually working with the technology of computers and data processing. Over time, his proficiency in the technology becomes less and less current—he becomes technologically obsolete and less and less able to perform his job. Eventually, he may be demoted, pressured to resign or even fired. He becomes one of the horror stories of the previously cited magazine article. To have a middle management union force a company to keep him in that position is similar to legislating against the amputation of cancerous legs. It is a disservice to the health of the organization and also to the individual who cannot help but feel less and less adequate to the demands of his job as time goes on.

The occasion of this individual's problem wasn't a discrete event like the installation of a computer, automation equipment, or the introduction of a new technology. Rather, the problem developed slowly over time as the technology changed while the individual failed to keep his knowledge current. I've seen many examples of this, not only in the computer field but in all areas of human endeavor which involve significant amounts of science and technology. And I include the businessman, because there is a large component of science in management these days. And the problem isn't confined to middle-management—it's just as prevalent at the top and at the lower echelons.

I've seen a number of executives who were psychologically in a bad way because they were aware that they were technologically obsolete and were no longer in control of the organizations they managed. These individuals had climbed to responsible positions in large companies; they didn't lack native ability. Rather, they had become "uneducated" for the job they held.

Let me put this another way. It used to be that an individual could go to school, take a job, learn through experience and do well until retirement—drawing in his later years, so to speak, on the intellectual capital he coined in school and on the job. This is now very difficult in many positions. Now the pace of things is such that significant changes take place in a period of time which is short compared to the life span of man. Today we find companies terminating men of a given specialty, while hiring young men fresh out of school in that same speciality. We find companies restricting the percentage of older men among new hires; we find companies in trouble because their managers are obsolete. And as I mentioned a minute ago, we find individuals psychologically disturbed because they feel that they are obsolete.

H. Bentley Glass, President of the American Association for the Advancement of Science, recently said, "A scientist must constantly renew, extend and reorganize his knowledge, or in approximately eight years he will be beyond hope as teacher or practitioner." (9)

We might think of two levels of continuing education. The lower level consists of evening classes, reading, or attending short intensive courses while continuing to hold a job. At the higher level, one would not attempt to hold down a job but would devote full time to education for a significant period of time (say six months to two years).

It seems to me that for many positions, the part time level is becoming less and less adequate—the individual uses up his intellectual capital faster than he can replenish it. If we were to suggest to a man in mid-career that he should consider taking (say) a year off to attend school full time, he would probably reply that he couldn't afford that—he'd have a serious capital problem—one measured in dollars.

If part time continuing education is going to be inadequate for many positions (and I believe it will), then society has a problem. How is full time continuing education to be financed? The tuition costs are a small part of the total—the major problem is that individuals will have to forego income while they are not working.

Last year the Prime Minister of Sweden, Olaf Palme, described a related idea of continuing education which he calls "recurrent education":

> I think the best way for me to illustrate the question at issue is to assume . . . that all post secondary education is organised on a recurring basis, that all people, after completing upper secondary education, go out into a job, that after some time at work they take another period of education, then return to a job again, pass through another period of education, and so on . . . For the individual, recurrent education ought to have several advantages. We all have a need for variety, whatever our occupation is. The student with educational neurosis and the person in working life with symptoms of stress would both perhaps get to grips with their problems if they were given the opportunity of a change of activity for a time. Leisure time would be used by many in a more valuable way than now and the individual would have a better opportunity to get to know his aptitudes. Absolute individual failures would be less common, as everybody would have a repeated second chance. (10)

The academic world has had a sabbatical leave system for a long time—it's part of the academic culture and employers accept the expense as part of the cost of doing business. The academic world also has its equivalent of the middle management union called tenure, but that's another topic. Can we transfer the sabbatical mechanisms to other industries? I suspect not, though a few large firms do support some activity along these lines. But it's infinitesimal compared to the need I foresee. The private sector is very competitive compared to the academic world and I just don't see industry incorporating sabbatics into their culture—it would just be too easy for some firms to avoid the costs of sabbatics and hire, at a small premium, the newly refurbished employees of their competitors. Thus, I see the need for a broadly based mechanism, somewhat in the nature of the social security system. There are problems other than financing such a system—the mechanics aren't at all obvious to me and motivation will be a major problem.

What might be the costs of such a continuing education program? Since I haven't and can't describe it precisely, a precise cost is impossible. But we can, I think, come up with an approximate cost. Let us assume that 5% of the labor force is involved in continuing education at any one time and therefore not working. Let us further assume that the cost per person in terms of both the foregone income and the cost of providing the education, is $8,000 per person involved per year. Assuming a labor force of seventy million, we get an annual cost of about thirty billion. That looks expensive. Can we afford it? We can if we want to. That's about 3% of our Gross National Product. It's less than half our defense budget. And it's about the same as the annual increase in productivity. Further, in time it would undoubtedly cause productivity to increase more rapidly. And ironically, it would also increase the pace of change—the very thing which makes such a program necessary in the first place. In that sense, such a program is somewhat self-defeating—we'll have to run even faster just to stay even.

An assumption in what I've been saying is that the pace of change is actually accelerating. Is that really true? Actually, not everyone agrees that it is. In particular, economists look at such metrics as the growth of productivity and conclude that it isn't speeding up at all. Sociologist tend to disagree with them violently—I'm with the sociologists. Considering the steadily increasing effort going into research and development, one would expect the pace to be increasing. Not too long ago, most of mankind was desperately engaged in producing enough food to keep alive—even today, in the underdeveloped countries of the world, most of the labor force is engaged in food production. In a highly organized industrial country like the U.S., a few percent of the labor force produces more food than our country can consume. This, plus our high level of per capita income, permits us to devote a significant portion of our large Gross National Product to research and development—thus generating more change. It has been pointed out that something like 90% of the scientists and engineers who ever lived are alive today. Considering all these factors, it would be surprising if the pace of change were not accelerating.

The computer is a major agent of such change. There is hardly an area of science, technology or human intellectual endeavor where the computer doesn't have a large impact on the pace of research and development.

Thus I believe that the most significant social implication of the computer is its role as an agent of change and the consequent fact that significant changes now take place in a period of time which is short compared to the life span of man. I've already told you of the problems I see flow from this as they relate to individuals and a need for continuing education. To put my point another way, man must learn to adapt in a rapidly changing world. And society must provide mechanisms which help him to adapt.

Institutional adaptation

Individual adapation isn't the only problem since institutional adaptation is very much geared to the life span of man—the old guard frequently stays on until retirement—especially in our public institutions. There are other hindrances to institutional adaptation in that they often have a great deal of built-in inertia. Large organizations cannot be moved rapidly. Our forefathers deliberately built a lot of inertia into our systems of government.

Society can afford to lose, through lack of adaptation, a few institutions in the private sector where there are many similar organizations. But in the public sector we have little redundancy; each country has but a single national government.

John W. Gardner in "How 20th Century Man Let His Institutions Go to Pieces" (11) stated, "The true task . . . was to design a society (and institutions) capable of continuous change, continuous renewal, continuous responsiveness." At times I can be rather pessimistic about the possibility of that happening. Individuals don't adapt very well and institutional adaptation (at least today) is tied to individual adaptation. To put the problem in the form of a pessimistic analogy—not only is the patient (society) ill but so is the doctor and the doctor's education and experience are not appropriate to the illness at hand.

Let me bring the matter a bit closer to home. The computer industry now claims to be the third largest industry in our economy, starting from a dead start less than 20 years ago. Some industry prophets predict that it will pass the automotive industry and become "No. 1" as early as 1980; others aren't as optimistic as to when but are just as positive that it will become "No. 1". I have argued that computers and communications are having and will have a fantastic impact on our society. If this is indeed the case, then one would note that one would find expertise in computer and information science well represented in the "establishment". Yet as I scan the distinguished roster of the Panel on Science and Technology, I do not find a single person representative of the computer and information sciences. And I would be most pleasantly surprised if any members of the Committee on Science and Astronautics had more than a passing acquaintance with computers and information science. Some of the panelists may have considerable experience using computers in their own disciplines, but from my point of view, that's like the difference between being a pilot and an aeronautical engineer. The National Academy of Science does have a computer scientist, Professor Anthony Oettinger of Harvard, as Chairman of its Computer Science and Engineering Board, but he isn't a member of the Academy. I presume the reason he isn't is that he's too young.

I hope I'm not being too parochial, and I certainly don't mean to condemn you for not being computer scientists. Rather, I'm trying to make the point that institutional adaptation is geared to the life span of man. And since so much change now takes place in a period of time which is short compared to that life span, institutions are having trouble adapting. Unless you've been to school in the last ten or twenty years, you're unlikely to have any formal education in computer science. But that means you're probably young, which means that it is unlikely that you are a member of the establishment.

I would like to point out that my own formal education was in Meteorology, not Computer Science.

Man's self-image

Computers, communications, and rapid technological change in general are all striking blows at individual psyches. Certainly the individuals who epitomize either the Peter Principle or the Paul Principle feel most insecure and lack a feeling of accomplishment and worthiness. The computer might be thought of as just one more step which began with Copernicus telling us that we are not the center of the universe, Darwin raising doubts about divine creation and Freud saying that we are not completely rational. The concept of an all powerful, infinitely fast comuputer is a real threat to man's self-image. It appears to him as something which competes in an area of human endeavor (intelligence) which he associates most closely with his own humanity.

I believe that most men do not have too much trouble in making the intellectual leap from the Fourth of July rocket to Apollo 11's trip to the moon. They are fantastically impressed, but they have a feeling that they understand the process. But the leap from the adding machine or desk calculator to the computer which can carry on a conversation with the user is one which is totally beyond most men's comprehension.

There are many computer specialists who believe that it takes at least a week of intensive instruction to teach "computer concepts" to executives—men who are way above average in intelligence and education. No wonder many lesser individuals feel that it is impossible to learn what computers are all about. And if he doesn't believe he can do it, he can not.

Several years back, an IBM psychologist did an interesting study which showed that a significant percentage of the population tended to think of computers as "the fearsome thinking machine". (12) As might be expected, this view was held less by the well-educated (24% of those with a college degree did not hold this view) than by the less educated (44% of those who had not completed high school). This view was highly correlated with feelings of alienation, suspicion, bitterness and with intolerance of uncertainties and ambiguities. In fact, once it is known where a person stands in terms of alientation and intolerance of uncertainties, variations in education makes no significant difference at all in predicting whether or not an individual will hold the "fearsome thinking machine" attitude toward computers. Alienation is certainly on the increase in today's urban society, so we shouldn't be too surprised if the percentage of the population who fear computers is also increasing.

Men feel that they just can't cope with the rapidly changing environment in which they live. Or they may just decide not to try to cope, as some of the younger generations are doing when they head for the rural areas to form their communes. This fear of a world that is changing so rapidly that one is unable to function well in his job, or in his role as a citizen of the world, is not confined just to the less educated. I believe the Paul Principle is operant at the highest levels of industry, science and government. I wish I were able to take a secret poll of the individuals in this room as to whether or not they felt they were an example to some extent of the Paul Principle. I'd bet that at least a third—possibly a half—of you would secretly admit to it. I know I would.

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Dr. **Brown**. I think Mr. Armer makes a very valid point about age, and as he was talking, my own thoughts went back to a similar kind of traumatic situation which emerged with the development of the atomic bomb. I happened to have been with that group, and I remember how terribly frustrating it was to most of us involved with that group. I think our average age was around 24, 25, something like that. And we descended upon Washington trying to get the ears of the establishment, and we had a hell of a time getting their ears in a way which was truly meaningful. And all I can say is that although progress has not been made anywhere nearly as rapidly as one might have wished, the mere fact that we are sitting in this room—admittedly with a few absent Congressmen, but with some who are present—I think is highly significant. We have still got a long way to go.

With respect to the academy, I can only say that the youngest people in our academy are mathematicians. At the other extreme are the geologists, where you have to be 80 years old before one geologist admits another is any good.

Thank you.

Mr. **Armer**. Understand I am not against age. It's creeping up on me, too. I am trying to break the correlation between age and the level of education. That's what I'm after.

Dr. **Brown**. Exactly.

Dr. **Bell**. Dr. Russell.

Dr. **Russell**. I enjoyed reading the book on the Peter Principle very much and subscribe to most of it. I have some question though about the Paul Principle. It seems to me that you presented with reference to businessmen, to executives, and it may well apply in that field. But when we come to such people as expert artisans, composers, painters, or an excellent chef, or many technicians, then I doubt that the Paul Principle obtains at all. You suggested that the Paul Principle would apply to scientists. Yet if we look at Charles Darwin or Alfred Russell Wallace, Leonardo da Vinci as a scientist, and many others, I see no evidence of the validity of the Paul Principle.

They kept on acquiring more and more wisdom as time has gone on. Yesterday I heard the universities so much criticized for not imparting wisdom, which I think is true, but could be remedied. I think that people in many fields, such as in the humanities, become more and more valuable as they acquire more wisdom. And so it seems to me that the Paul Principle is more directly applicable commercially than in most other directions.

Of course, there are people who deteriorate in a short time in any field. But I think as a principle, the Paul Principle will not have the wide application of the Peter Principle.

Dr. **Bell**. Mr. Miller.

Chairman **Miller**. Well, I was going to say that I don't think that the complaint that age discriminates against youth or tries to hold youth down is peculiar to our time. I have been in Congress for 26 years. During the first session that I was here I was on the Post Office and Civil Service Committee. We had a bill before us to create 150 superjobs at $14,000 a year. The principle up to that time had been held to in the Government that no man should be paid more than a Member of Congress, and Congressmen were getting $10,000 a year. General Grover and Dr. Vannever Bush came before the committee pleading to get more money for people that they wanted to hold. I remember a very distinguished Member of Congress at that time who was on the committee who was very much opposed to it. He said to Dr. Vannever Bush, if you get these jobs, Doctor, you are going to get a certain percentage in them in the atomic energy world. Who are you going to pay $14,000 a year? Dr. Bush said, well, I forget the name—Dr. Jones, and he named some facet of the work that he was engaged in. This fellow said, well, how old is he? Oh, he said, I don't know how old he is. I have never asked him. I think he is around 28 or 30. 28 or 30? And you are going to pay him $14,000 a year? Oh, he just raised the roof. So this has been going on for a long time. Fortunately, we got the bill over.

Now we have advanced this thing so that $14,000 or the pay of a Congressman is no longer the limit that people can be paid in the Federal service.

Dr. Bell. Dr. Whipple.

Dr. Whipple. We rarely discuss religion here, but I think the relevancy may become apparent to the subject. As an astronomer, I have always been quite interested in astrology, because they were born together, and astronomy is an offshoot of it. And I notice the young now are turning away from the more classical emotional religion, and going into astrology. And it seems to me a rather ideal religion, that insofar as I can see, very few people have been killed in its name. Most religions can claim millions at least, if not tens of millions, having been killed for their soul's sake. And it seems to give good advice. Its tenets seem to be sound enough, except of course there is so far as I can find out no rational basis for it. At least no factual basis, and that's also true of most religions. But the interesting point I want to bring out is that those who are now turning in that direction are in considerable measure people who tend to be antitechnology, antiscience, and certain anticomputers. But the anomaly is that it seems to me astrology is the ideal religion of the future, the ideal computer religion, because if you take the tenets, as I understand them, they are based entirely on the positions of the planets and when you were born, and the astrogeometrical conditions of the movement, and consequently all of this is easily programed and fed into a computer, so you really don't need a priesthood to advocate the religion, and so far as I know, no research is being carried out to prove any correlations between the birth of people and the positions of the planets, and the fact that we are going into Aquarius, and having effects that really are demonstrable.

So I merely point out that it looks as though the youth turning in this direction are in fact turning toward the computer as a religion.

Mr. Knox. Dr. Bell, I have a comment with respect to the importance of the computer/communications technology, and at the risk of assuming there is a problem in communication here that really doesn't exist, let me just point out it seems to me that there are certain functions in our society where information acquisition is still central, and this applies to many of the scholarly disciplines. However, there are also many areas of activity where information manipulation and communication are rather the central functions, and it is in these activities that it is especially important to have experts in the new communication and computer technology. And in these types of activities, I think, we can easily manage the education, the Congress, business, administration of all types. These are organizations and activities where information manipulation and communication, fed back and forth, are central to the purpose of the activity. And I think the orders of magnitude change, that Mr. Armer referred to. It should make us all aware that these activities are especially vulnerable to changes and, in fact, should see the opportunity of these orders of magnitude changes, to become something far more effective than they have been limited to so far.

I am sure anybody in education, the Congress, business, administration, any of these activities, has been frustrated many times by his lack of ability to assess the information that he wants, when he wants it, on the terms that he wants it. And, likewise, he has been frustrated by an inability to communicate both from him to someone else, and also to find out what someone else thinks about it.

The new technologies are truly fantastic, and they are so fantastic that they are beyond the comprehension of many people, and where people don't believe that something is possible, it is very hard to get them enthusiastic about striving to get it.

We had to believe that it was possible to get to the moon or else we never would have organized the space program.

It is that kind of thing. And I do believe that as Mr. Armer points out that the changes in our capability to communicate, and to process and manipulate information offer us fantastic opportunities to get away from the limited forms of communication capability we have had so far, or information processing such as libraries, and to get to something that is at a much higher stage of evolution.

They offer us the opportunity to get away from the Henry Ford mentality, to go to the Albert P. Sloan approach of building ladders of consumption, because of the infinite variety of formal products and service that will now be possible at varying cost levels. And I predict that this will be a trend of the next decade or so. I would like to second, I think, his basic plea for increased awareness of the tremendous potential inherent in these technologies, and to try to make full use for our human benefit.

Thank you.

Dr. Boorstin. I would like to comment upon the problem of privacy, which Mr. Armer has made some interesting remarks about, and especially his suggestion that there is a need for a privacy bureau.

I have some misgivings about such an entity, which I think might aggravate the problem which it was intended to solve. I would like to suggest that the problem of privacy and the inviolability of the individual really is connected with technology itself, and it isn't always a question of the prying or the intrusion of an outside agency. It is also partly a problem of the way in which the market itself and the technology of market research has induced people to want to have their privacy intruded upon.

For example, the rise of opinion polling seems to me to be one of the most significant phenomena in the history of the decline of the privacy of the personality. People who might think they would be entitled to have their own opinion about some product or about their relationship to their wives or to their household or to their children will patiently answer a questionnaire at great length and without compensation on all sorts of intimate matters. The rise of opinion polling indicates the willingness of people to be intruded upon. And soon they welcome it, and sometimes people even feel as if they are being slighted if their opinion has not been asked, even if they have no opinion on the subjects inquired into.

Other phenomena that are relevant to this are television which intrudes into our living-room conversations of persons who often have no place in our living-rooms and whose conversation is quite irrelevant. The willingness of people to watch other people engage in boring conversation shows their determination to have their privacy infringed upon.

A third phenomenon is the rise of psychiatry. Now there was a time when people would go to their minister or perhaps even to a parent, or maybe, failing a parent, a grandparent, or an aunt or an uncle, and confide some of their personal problems. Now they go and they pay for the privilege and pay handsomely to some stranger who does nothing but listen, and who often gives very little advice in return, except to say come back again.

I think that the problem of controlling privacy and of retaining the privacy of the individual inviolate is not a bureaucratic problem basically. It is basically a problem of building up among people the expectation that they have individualities which are worth keeping inviolate, and then developing a resistance to intrusions which do not either embellish or even reach their personal lives.

Dr. **Bell.** I will just as a footnote to Professor Boorstin's observation which as a practicing sociologist, I think one can say that we are all subject to the fact that everybody does want one's people to have opinions. So you are asked, "Yes." "No." "Don't know."

I will predict to you that if anyone had the courage to start with "Don't Know," "Yes" and "No," the percentage of "Don't Knows" would start up so high we would probably have an end to opinion polling in this country.

We are under the operation here of the Chronus Principle. The Chronus Principle moves us along very, very inexorably. I am going to ask Mr. Armer to comment on the statements he has heard, then move to Dr. Kozmetsky.

Mr. **Armer.** I will comment on a couple of them. I guess, first of all, with respect to the Paul Principle, I do not claim that it is applicable in all instances. I think that its applicability is fairly wide, however. And I would like to make one quote with respect to that, and then tell you another instance as further evidence.

H. Bentley Glass—This is a quote out of my printed remarks that I did not say orally—who is president of the American Association for the Advancement of Science, recently said, "A scientist must constantly renew, extend and reorganize his knowledge, or in approximately 8 years he will be beyond hope as teacher or practitioner."

Now, granted that there are many scientists who do constantly renew, extend, and reorganize their knowledge and therefore do not become examples of the Paul Principle. But on the other hand, there are many who do not, and I think they then become examples of that.

A further example of this sort of thing, I discovered recently that there was a program of continuing education in the Stanford Medical School. So I thought I had found out a little bit about it.

One of the things I was interested in was essentially did they go after the M.D. who had been practicing in the field for 30 years, or 20 years or what. And I was really shocked when I found that this program of continuing education was intended for the man who was about to graduate from medical school. The feeling was that the education that he had gotten in premed was now obsolete.

With respect to the most recent comments about privacy, I guess I take most of the tenor of the argument to be that, well, maybe we don't really need to worry about privacy, because people don't want it. I guess I feel that there are lots of them that do, and at the moment the best way that I see of trying to provide that for them is through some agency having responsibility for worrying about it, rather than just leaving it alone.

Thank you.

Dr. **Bell.** We are moving ahead now to the papers on education in a changing world, which is, how do we adapt to some of the questions which have been posed by Mr. Armer.

Our first speaker is Dr. George Kozmetsky. He has had a rather unique career, moving back and forth in a rather dazzling display of lateral mobility between the academic world and business world, now back to the academic world, where he is dean of the School of Business Administration and Graduate School of Business, at the University of Texas. Dr. Kozmetsky.

STATEMENT OF DR. GEORGE KOZMETSKY, DEAN, COLLEGE OF BUSINESS ADMINISTRATION, AND GRADUATE, SCHOOL OF BUSINESS, UNIVERSITY OF TEXAS

Dr. **Kozmetsky.** Thank you, Mr. Moderator, members of the committee, distinguished panel members, guest panelists, ladies and gentlemen, I am honored to have this opportunity to appear before you on a subject as vital to our Nation as "Education for a Changing World."

I can't help but be impressed as an academist on the requirements which have been verbalized, and many yet to comment, which we are expecting our editors to provide for today's youths and the youths to come.

It is quite obvious no one person can encompass the whole field of education, and I think it will be quite clear that I am interested in the area of educating tomorrow's managers, for I guess I have said so many times, a manager is insufficient to have just a lifetime of experience in this highly technological and scientific society we live in, and I think it is equally true in lifelong learning is insufficient without relevant experience. And it is for that reason that managers must be trained and developed to have abilities to learn by analog or esoteric boxes, if you please, in a continuous process from formal education to experience, and from experience back to formal education, as well as through personal learning, interrelated by communications within a network of reality.

I think it is appropriate that I get quite specific about what I am going to be talking about, in the narrow area of which I am speaking, because in setting up the graduate school of business, in training of managers for the last third of the century, I stated quite succinctly, a quick reflection about the future brains, the management of this challenge and the clear focus needed. Managers must deal with the emotional and behavioral, as well as technical changes, learn to converse in the appropriate language of mathematics, communicate with and perhaps manage scientists, engineers, accountants, and artists, use sophisticated new tools for effective planning and controlling strategic and tactical design making, and understanding and implementing the social and individual value systems, including self-liquidating ideals of our Nation.

In essence the managers of the last third of the century must be cross disciplinary and must embrace new methods and techniques. I am sure that you get from this reading that by managers I am not talking just business. Congressmen are managers in the definition that I have just given. Presidents of universities, heads of scientific foundations, heads of universities, are managers in the sense that I am talking about.

In this sense, the editors today are facing relatively the same question asked by George Counts, of Teachers College in the 1930's, at that time quite a controversial radical professor, when he delivered a speech called "Dare the Schools Build a New Social Order?"

I might state that the response to that was fairly quick to ignore it; it was fairly easy to handle, and perhaps quite fortunate that it was dropped. For many of us in this room, we are students from that period to today, and we can well see, looking backwards, the social order which we helped to develop.

And if we pause to review quickly what we need for the period, the need for high mental capability is needed in the society that you call the post industrial one, and I think just in passing I would like to say even the practitioners of the futuristic heart, like Herman Kahn, have already heralded the need for the extension of the more technical skills in order for our Nation to enter, which I think we have been saying in various forms today, a meaningful community of humanity.

Now, I think it is worthwhile to renew just briefly some of the things that have been happening in education, particularly technology has been advancing, and if you will excuse me one must fall back on a philosophical note, for an early manifestation of our education since World War II was to stress excellence in education through excellent teachers and excellent students. We have seen that our universities have changed their tougher academic entrance standards, for their professor staffs as well as for students. They initiated and maintained more academic specialization, especially at the graduate levels, Qualitatively, the faculty of my size is in-depth knowledge, quantitatively, the faculties increase the scope and amount of reading expected from your students, especially since the Sputnik. Research by individual faculty members and individually selected and sponsored by government or foundation grants have prospered in this period, though it became fundamental to discuss in many meetings "Publish or Perish," and it is delightful to be here because the fundamental question you are asking editors today is what has our research added to the state of knowledge. And I am sure in Mr. Armer's terms that would be information.

Now all of these have the peculiarity of increased emphasis on excellence as a standard for our community of scholars. The accomplishments are notable and perhaps because too often in education we simply look at degrees we have given out, rather than the needs of our society, so let me look at the output from the esoteric box of higher education, by simply stating, between 1950 and 1965, we have turned out over 4 million graduates which was 80 percent of all the college graduates turned out of 1950 in this country.

We have had many advantages in this, and we certainly have had many problems that arise from this. And again, we are facing the issue in the 1970's, "Dare Schools Build a New Social Order?"

Now we are aware, be it from the youth, be it from the Middle Ages, be it from the establishment, be it from any emphasis at all, that excellence in education is at best a short-term objective because the advances of technology in our society demand all levels of intellectual talent for building a society emerging from what I would prefer to call the second industrial revolution, rather than the post industrial period. We are in a new technology which is evolving whole new industries, whole new demands.

There is very little difference, if you are reading my papers between the second industrial revolution and the post industrial revolution that has been used up to now.

They are interchangeable. But I just want to make some points because what I want to do is show, if you will look in 1860, which is a good period always for a Texan to start with—you are all familiar with that—but if you will look in 1968, from 70 percent of our people were gainfully employed in mass production and service industries; if I go to the Federal Government, there are over 700,000 enumerated at the professional positions.

Up to this point, in higher education, and to a lesser degree in secondary education, we have been emphasizing training and developing and educating people for that segment. I have slightly redefined the nonroutine industries which I will get into shortly, as that 20 percent which includes, I think, the intellectuals, and most of you in this room are in the nonroutine. You wouldn't consider yourself in the service industry.

Now, what is happening is if you put any number for population expansion from 1968 to 2001, you will find it quite a problem. I have tried to put the problem squarely in the middle and you can change numbers wherever you like. I can have 50-percent error, and my fundamental problems don't disappear. In the year 2000, I casually said to myself there will be 80 million people gainfully employed in mass production. There will also be 80 million people gainfully employed in the nonroutine industries.

If you don't like that half and half, change it any way you want. For the fundamental thing that we are talking about is how do we educate for both mass production in the service industries, and the nonroutine?

Now, the transition in this period is not going to be easy. I think that it is worthwhile to just simply call to your attention that editors have been involved in the problems of transition and I am not going read or enumerate them to you today. They are quite easy to see. Philosophically we are making changes. For example, education we have thought of as a privilege. Now we are sort of talking about it as a universal necessity, and we must recognize that education is also in a state of change. But I think as one of the panel members said so succinctly this morning—and I would like to just simply read it in more academic terms so I can live with my faculty—that in spite of all of the above pressures and changes our principal problem in higher education is widespread, habitual, institutionalized resistance to needed change.

Now, the semantics are kind of bad. I don't know what cybernetics is in terms of application, as a social scientist I understand at least what I mean by it, and I am going to use systems and cybernetics programs interchangeably in my papers, and the application of system concepts to all aspects of higher education is still in its infancy. By the same token, there has been minimal application from the field of cybernetics to higher education as an information system.

Systems concepts and other principles are found in all phases of scientific discipline that are represented in this room. Only recently have many of our institutions of higher learning become interested in their application to the universities. This is only natural, for the emphasis upon a systems methodology has come from both the sciences themselves and the double-barreled major thrust of modern industry, development and recognition of many of our social economic problems.

These thrusts which in turn have made possible exploratory systems methodology of creation of principles, techniques, tools for their partial solution, have provided the main impetus for considering education as an information system.

And it is in the same sense, then, that I think that some of the things which have been done by our astronautical programs in the United States in terms of managing complex technical programs, that perhaps not only should industry gain outside of aerospace but it is equally applicable that it should be applied to education.

Like all things, I am sure of that caveat we are all aware of, you simply don't take something and then twist education or business or anything else into what has been done in the management system of NASA.

It seems to me that one of the major problems that we have in focusing upon education as an information system, and especially in the nonroutine or technically based industries that I pointed out on the chart, is to quickly scan some of the studies which have been done by the National Science Foundation to simply focus upon the magnitude of the problem of trying to distill information.

Here I have attempted to try to show the implication of technological information explosion. At 1910, if we considered that a dot, and we simply didn't take Paul Armer's figure of technology in its information doubling every 8 years, this chart is drawn for every 10 years. The dot expands from 1910 to about an inch and a half in 1960, and at the same rate continues by the year 2000, it will be 23 inches.

We find that in studies the National Science Foundation conducted, that 1 hour a day over that bar, which is a brownish color on the bottom, is spent in searching for information, 4 hours a day spent in reading, and 3 hours a day spent in doing new meaningful work, and of course the thing that is wrong with that bar is none of us can get by with 8 hours.

If we take a look at the technological research being done on the informational problem itself, in 1960 the Federal Government invested about one-half billion. The whole work we are doing on information retrieval is based upon trying to minimize only that 1 hour of finding documents, which still leaves, if you have got rid of it completely—and the chart shows it doesn't—it would now give us 4 hours of reading and 4 hours for meaningful work, and it still isn't done.

I don't like extrapolations. Down there it says if we simply carried on research in this whole informational explosion field at the same rate we have in the 1960s, it would expand into close to $24 billion.

Now, what does this means more specifically? If you believe in a 5-day week and that is what that is trying to show, let's go back to 1910. Any scientist, technologist, or manager, in the sense I am talking about, to keep up to date with all kinds of technology would simply have to read a stack of periodicals, 1 by 5 by 1.

The next shows that in 1960, that weekly reading was turned to 3 by 1 by 60. And if we continue by the year 2000, it will be 15 by 5 by 60. I usually add for the benefit of my friends in psychology no matter how much the technicians put it into microfilm, or into any other form, the amount of data and information is still large.

The figure with that educated hat on the bottom is one that is a manager. Another National Science Foundation study pointed out in 1960 that at the time we were concerned about the brainpower, and they measured brainpower quite simply, by the number of college degrees.

It shows in the inner circle there, in green, that if we took the free world, meaning the United States and Western Europe, we had about 70 percent of all the graduates in the world. This extrapolation showed that if we continued at the same rate that we were turning out college graduates in all nations in the world, by the year 2000 we would get down to about 30 percent, and those of you interested in the details, can ask me are the Russians our competition—you will see they relatively haven't changed very much, they have maintained their relative range.

Of course we see China and other parts of Asia coming in. As a manager it seems to me the whole notion of competition and new industries, in the post-industrial society, is going to be different. I think I will just rapidly show you the last chart, because out of this it says that—if you look up there it says that as an educator we have one constraint, 24 hours a day. We have two broad alternatives that are not satisfactory. One is to give up and just enjoy the good life. The other is to dig yourself into an early grave.

Of course we want some kind of a balance, and the NS stands for what should we know about natural sciences, A is arts, SS is social sciences, and T is technology, and PS are the physical sciences. And we can look at the various professions we are going to need in this post-industrial and sort of extrapolate the extent we need more than the brown person way over on the extreme left, the average one and that is sort of useful in trying to formulate our curriculum at our college.

Now, higher education's approach in the past has been to do research in bits and pieces, and to incorporate results into the curriculum on a piecemeal basis. When viewed from the application of communication and information principles, such research commingled the data and information so that it covered the need to identify clearly the additions from research to the current state of the art.

The question to ask in this postindustrial period for those who are going in the nonroutine industries of our educators when we research, what have you added to the state of the art, not what have you published. Now, advances in techniques are in the process of teaching and the advances in the learning process by the student.

Now, this method that we have been using in the past has three significant drawbacks. First, current instructional methodologies are often inadequate vehicles for the transmission of the product of research. Conventional teaching methods in the area of management decisionmaking or modeling, as it was called in the first morning session, for example, do not lend themselves well to the teaching of newly developed techniques of modeling.

There are over 1,000 techniques of modeling today. I simply ask faculty members when they are making up a course to tell me what is the average time they are going to require of reading outside of class, and gentlemen, it always comes out to such a large number, but in order to get such a course passed you put it all in, so each faculty member can see it, so he can vote it in, and then the professor says regardless of whether it is a required course, it is my course, and I shall teach what I think is important.

And this strikes at the heart of the feedback system of academic freedom to select courses. I am always after them to say please, what feedback system are you using?

I am naive enough yet to think it ought to be the examination, but again, as any of you who are experts in this room in information and communications know, we have never used the examination as a feedback in what we think the state of knowledge or techniques which are absolutely essential for any of the professions to be used to help enhance our way of teaching.

Now, I think this method of modeling is going to require conversational usage of the computer in the integral part of our instruction methodology, so they can keep track of these thousands of methods of modeling. I simply want to train people to start interrogating computers as managers that pose their problems in clear English, so that it can say, yes, master, we have a dozen techniques which are useful for you.

A second drawback is that current methods of curriculum change yield curricula that may have certain outstanding areas, but when viewed from the perspective of systems analysis, rarely exhibit the coherent structure and are often plagued by inadequacies and redundancies.

This summer on our generalized unit model project we asked a simple question. What is required to turn out a professional undergraduate in business? Now, I am talking real low—accounting, finance, marketing. We have 17 such of these. It was very startling for me to find out that a professional person in today's colleges of business for the undergraduate level cannot take more than 9 semester-hours.

The balance that make up 120 are generally to make sure he fits the university requirements which I will be kind enough to say is to make him into a rounded citizen and the other courses are those which the faculty of the College of Business have said he needs to be a rounded businessman.

Now, these then say, If I were looking at the postindustrial society, and simply saying from a curriculum point of view, yes, I do want to need professional people. If it is true that our youth are pointing to and including some of us old-timers with or without a beard, that we are seeing the change and changes in the self-liquidating ideals in our arts and our sciences, in our fine arts, and where are the courses?

And finally, if we are living in a changing innovative society, where are the courses one must take so that one gets innovative on his own? For continuing education, as Mr. Armer has pointed out, is a $30 billion business, with no institutions to handle it if you had the money.

I took the time to see if we honestly needed continuing education jobs. Just imagine pumping through 40 million people in today's educational institutions.

It is quite difficult to see, with the overloadings that we have now. Historically I can only look backward and say one of the things that I wish I had had is that I had been taught enough mathematics so that I was never frightened to read the advances coming along.

Not that I could find the origins or the proofs, but simply to learn it as a shorthand. And there are many other examples I am sure you all know. The third problem that I find is that I am required to transfer the relative findings of research to specific areas of knowledge and/or techniques, while the appropriate method of teaching a specific course is so extensive that often it is outdated by newer research before it is utilized.

I think putting it quite frankly, one of my problems is not only points, I have assumed that the research has been published. But I dare say the thing which each of you in this room is aware of, many breakthroughs that haven't been published, which forces us back to how does one bring into our courses advances which are not yet published, but which we know about?

I tried to see how difficult it would be to move faculties to start using what so many of you are interested in—computers—and I want to make clear here I am not for CAI, computer-assisted instruction. I am not against it. I am not for batch processing, or simulations, nor am I for or against time-sharing.

We have so little knowledge in the use of these computers for all of these methods that I frankly don't see how any school can get by without them. For I have found it is a thrust of providing such things for your faculties that brings it about, and we were quite fortunate in having Mr. Thomas Burke, who was the acting head of the computer laboratory for NASA's new electronics laboratory, come down to get his doctorate, to work on this problem with us, because we were naive at that time to think we needed the new random computer or the whole new thinking machine to be brought in, which was obviously going to be required for those Pluto explorations.

We thought we had gone that far. But what interested us was that when we provided a terminal, good or bad, for any of these methods in the faculty to use, that he began working and never got frightened of it. Obsolescence is just as real a problem for educators as for any other ones that Dr. Armer pointed out.

I wish to pass only a sample of one. If we took a 42-year-old assistant professor, back 2 years after 11 years as a financial executive of U.S. Steel, who we wanted to teach portfolio management, who had never heard of Harry Markowitz or his book, who admitted after 2 weeks of letting him have the book that he could not read it, and he also admitted that he was at best a poor computer programer.

By getting a Ph. D. student from the mathematics department, from a computer science department and one from the finance department, if this gentleman was testifying here today, you wouldn't believe that he didn't have the man, didn't have the computers.

It took such a startlingly short time, 12 weeks. The methods which he had used incorporated the tapes which have 2,000 corporations, all their financial reports, in comparable form for a period of 25 years, and new teaching techniques going on that he and these graduate students have brought is fantastic.

Needless to say, I think it is important to this group to know, it is not normal to provide any assistance to our present-day faculties. One is forced to bootleg, in the most appropriate of aerospace terminology, their academic salary, to provide such help to your faculty. Such things are needed quite desperately.

I would like to just quickly move on to define a little more specifically these nonroutine industries and I don't think I have to linger on that capitalism that you hear so many businessmen talking about and which in my paper I try to approach from a historian's point of view that we have gone through several phases of capitalism in the United States, and it is obvious we are now moving into a new form, and for the lack of any better words, from listening to the panel discussion and interrogation, I hope you agree with the words. I just mean creative and imaginative.

So there needs to be imaginative needs of what are the industries we want to bring about. I just have a simple way of discussing the new nonroutine industries. As I have listened on pollution, I have heard it discussed as a disease, I have heard it discussed as a problem, and under creative capitalism, you have now defined a new emerging industry.

We would spend at the Federal level $10 billion. That is half an Apollo program. The State of Maryland is thinking of spending just for fresh water close to $10 billion over the next 10 years.

New York the same. California the same. And our voters voted it down in Texas, so that the pollution industry today is somewhat in the neighborhood over the next decade of two to three Apollo programs.

When you talk about crime, you are talking about the crime industry. And when you are talking about urbanization problems and all the poverty, that, gentlemen, is opening up new industries which I have discussed as nonroutine.

I make a slight plea there, that we don't put all of our research and science and technology into those areas. I sort of look upon them as decaying problems of the first industrial revolution. We are in the midst of the second and I would hate to see us continuously wrapped up into crises.

And I find it is extremely difficult in this post-industrial era to identify new problems which are going to come about. And one of my simplest ways of doing it, if you will excuse me, it was my training at Harvard where we teach about the case method, which is simply to ask questions.

What will the new industries in the United States be? They have got to be started in this decade, not in the 21st century. Steel has been very predominant in our discussions here. I am wondering if there is going to be a predominant steel industry in the United States in the 21st century.

I always smile at the honor of being at a U.S. Steel board meeting when they were shocked to learn the Japanese were putting steel into Pittsburgh to build a new stadium. It is fairly obvious that these new industries are going to have an impetus from science and technology, and when the Federal Government as well as the State and local governments decide where to put research, where it captures the imagination of a relatively stable group of scientists and engineers that we now have in this Nation, at least over the last 5 or 6 years, we have turned out, relatively speaking, larger numbers, because with the same technology they can do more.

And let me be specific. When I happened to be involved with airborne digital computers, the first one took 300 circuit engineers. That was 1954. In 1965 we are involved with the last one. It took 30 circuit engineers.

This morning I had breakfast with a group in the next generation, and it is taking three circuit engineers. So that they, too, have brought benefits within science and technology. And it seems to me that as I look at where the science and technology dollars for the Federal Government are going, we see a half billion in oceanography research. We see two and a half billion in biomedical research. We see three and a half billion in space.

We are going to see something close to, I don't know what the education research is going to be, but I guess today I would say whatever it is, not enough. But at least we will see a knowledge industry coming out of that research.

I think that things we have been talking about—individual values as an industry, leisure as an industry—obviously we have various leisure industries. I usually say to my students, when we assign them problems in creating these industries, where is the lower middle class? For the establishment type, for the hep kids, I usually say, where are the low-salaried employees? Where is their Palm Springs or Miami? How would you build it up?

And that is almost facing the problem which the President put so succinctly, how and where do we build new cities? If you had a monopoly of construction you could have anything you wanted. We could tell you what our working force is for today, what techniques do we need for 20 years from now.

Now, redistribution of wealth is extremely important, but I won't linger on these new ones but there is a characteristic in the nonroutine industries that I would like to just briefly share with you. First, the art technically based and their products have a relatively high proportion of technical and professional labor in the final product.

Second, there is a continuous shift at high technical content within the activity from the final product to its tooling or processing. The number of final units are not large, in fact they can range from one of a kind to what could be generally recognized as a short-run production problem.

Just as we pointed out yesterday, a water pollution program for San Antonio is not the water pollution system for Los Angeles or New York or Washington, D.C. At the lower levels we may find some equipment and other things, but certainly not the systems as a whole. And I think the next one is quite familiar to all of you.

The problems and processes involved can be typified as messy: that is, there is no single clear-cut solution included in scientific and engineering principles. Often specific solutions must be invented on the spot.

Fifth, the nonroutine activities utilized large quantities of intellectual capacities. And I didn't say IQ. Therefore, they do use all the people in our society, and I have decided to call them semitrained technicians and laborers, which I prefer to call professional laborers or to denote scientists, social as well as physical.

And of course my bias shows in the last point. The management of these nonroutine activities is extremely important, and financially I realize that none of this can come about without the management that is required to coordination of government, universities and industries, and in the rush to change the current institutions, it is fairly obvious we are going to see over this decade the Federal Government, industry and universities bring about a new affluence.

What this leads to in the nonroutine is to ask a fairly important problem that I think quite applicable at least in my experiences in space. The problem was a marvelous accomplishment. I was extremely biased. If I had my way I would like to see more of it.

However, it was a single objective. Put a man on the moon and bring him back safely. I think many of the values and objectives in education have also been single, and I think you can't move into the innovative or nonroutine industries without realizing that we must have multiobjectives.

My favorite example and an extremely biased one is if we are to have a soft landing on Mars in 1975, could you please accomplish that plus the following for only 10 percent increase in the R. & D. budget; provide a building material for planet earth that is 25 cents a square foot, including air conditioning and heat.

And third, provide for me a method of reducing diagnostic costs in selected areas by 10 percent. Now, as a manager, you only stick your neck out on things you have a fairly high probability of doing. Already the first part is under way. Project Viking is headed for a soft unmanned landing on Mars.

No real new needs have to be done for the 25-cent a square foot habitaton on planet earth. NASA has funded a study of what the moon base looks like. It is built out of a plastic from Goodyear. It does cover somewhat over 10, 15 acres. It has been under test for 6 years. It is particular. It is in Ohio. They even let snowplows crawl all over this. They have already built greenhouses. They have already grown food under it.

The problem I offer and think of is how does one convince a tire company to make a donation to a university of this plastic, so I can put it between the walls of the building I have to place my students' lounge outside, so I can grab that lounge and turn it into an experimental classroom.

It costs today $1 a square foot for research laboratories, and some of the new things which we are all dreaming about can be used—the latest one, supply a mass spectrometer. Ten pounds, according to the specs, tying into a gas phenometer.

There are 10,000 hospitals in the United States. I don't know of any noted medical university that doesn't want a mass spectrometer for its research. Obviously, if we could just simply modularize it, because we already have design principles and techniques, we could come up with a mass spectrometer and put the United States into the industry which I call medical instrumentation, because medicare costs are so high and we have to simply automate, and it would provide the—so I think what we are really looking at is for education, and it is so clear if we try to pull the information out, we have to work with multiobjectives. For those of us who are researchers we already know we have got enough tools going in the back shop that it could be done.

And I think that in closing that these computers are just vehicles and thrusts to bring change into education. I am in complete agreement with one of my newly formed acquaintances from the University of Illinois. I think they are headed in the right direction. They do need special purpose computers for educational purposes and new displays and other means of conversational method.

They are fortunate in that they have talent, the ability and most of all the will to do that. So I think in closing, all I can say is that I think our universities have real problems in bringing in some of the advances and identifying of the new professions that are nonroutine.

How we evolve this and partially use them, compute, partially from projects we assign, because we are in the best of all positions for this one. There is no knowledge to transmit. It hasn't been collected. We can start. We have frameworks, such as Dr. Beer presented, to see if they make problems for us which I am sure we can find solutions to.

And in many respects I don't think a simple extrapolation of today's developments is going to bring us to ecstasy. All I can plead is that the future has got to be managed, and I think the institution of education has the capacity and the will, if not the resources.

(Dr. Kozmetsky's prepared statement is as follows:)

STATEMENT BY GEORGE KOZMETSKY

I. EDUCATION AS AN INFORMATION SYSTEM

Mr. Chairman, members of the Committee, I am honored to have this opportunity to appear before you on a subject as vital to our Nation as Education for a Changing World. Our subject matter can best be exemplified from a management point of view by the quotation: "For a manger, a lifetime of experience is no longer enough." Nor is a "lifelong learning" sufficient without relevant experience. Managers must have the ability to learn by analogs in a continuous process from formal education to experience and from experience back to formal education as well as through personal learning interrelated by communications within a network of reality. In this manner, we can visualize education as a "continuous process" involved with multifaceted information systems that permit tomorrow's managers to stay abreast with or even enter into a varied multi-career.

There are no higher education institutions for the development of managers with multi-careers, or courses for such innovative management. And if one were referring to the kind of management required over the last third of this century and the first quarter of the 21st Century, then there are very few, if any, universities concerned with the problems. Yet it is becoming one of the great socio-economic-cultural requirements of our day.

One must, at this point, be personal. In September 1966, when I assumed the deanship of the Graduate School of Business at The University of Texas at Austin, it was my dream to develop an educational program for the American manager of the 21st Century. In the pursuit of this goal, I have kept uppermost in mind the explicit caveat of Harold Laski: "When the leaders of a people ask their followers to diet for a dream, those followers have a right to know in whose behalf the dream is being dreamt."

More specifically, as a Dean and a hopefully dedicated citizen, I established for the college the following guiding objectives:

In order to become one of the best colleges of business in the nation, at least two very fundamental requirements must be met. First, the college must have its own objectives which are achievable and which reflect primarily the needs of its students while at the same time recognizing the development needs of its faculty, its society, as well as government and industry. Second, the way in which the college initiates its objectives will to a large measure determine if it will successfully meet them.

The objective of the Graduate School of Business is to train the managers of the last third of the 20th Century. More specifically, the college must educate the future managers of the technical and intellectual resources of our nation. This charge is an extensive one which challenges all of the college's ingenuity and resources.

A quick reflection about the future brings the magnitude of this challenge into clearer focus. Managers for the last third of this century must: deal with emotional and behavioral as well as technical changes; learn to converse in the appropriate language of mathematics; communicate with and manage scientists, engineers, accountants, and artists; use sophisticated new tools for effective planning and controlling strategic and tactical decision making; and understand and implement the social and individual value system of our nation. In essence, the managers of the last third of this century must be cross-disciplinary and must embrace new methods and techniques.

This presentation includes the more relevant experiences, accomplishments, and researches to date of the faculty, students, and my colleagues at The University of Texas and other institutions with whom we have collaborated. I would be remiss not to mention my gratitude to a great many individuals who have helped shape the thoughts and ideas reflected herein. A complete listing is impossible; however, among those at The University of Texas at Austin who have had particular influence are Professors Eugene Konecci, Floyd Brandt, Abraham Charnes, Lanier Cox, Lawrence Crum, Edward Cundiff, David Huff, Gaylord Jentz, Judson Neff, Albert Shapero, C. Aubrey Smith, Burnard Sord, Tom Tucker, Ernest Walker, and Glenn Welsch. My academic mentors of the past including Professors G. I. Butterbaugh, Ed Learned, and Georges Doriot provided me with the necessary academic foundation. My associates in academic and industrial research include W. W. Cooper, Herbert A. Simon, C. B. "Tex" Thornton, Roy L. Ash, David Learner, and Henry E. Singleton; they gave me inspiration to approach in a direct, systematic and pragmatic manner the problems under discussion. Equally I am grateful for the assistance and close collaboration of Carl Mueller, Bud Coyle, Fayez Sarofim, Jim Bayless, and Arthur Rock for the insights gained for relevant entrepreneurship formations for tomorrow's industrial society.

II. SYSTEMS ANALYSIS FOR INTEGRATIVE HIGHER EDUCATION PLANNING

Today educators are facing relatively the same question asked by Professor George Counts of Teachers College in the 1930s, "Dare the Schools Build a New Social Order?" Let us pause for a moment to review quickly the change in higher education philosophy since the 1930s. It became somewhat clear to educators between 1939–45 that the armed forces needed high mental capability as contrasted to physical capability. This was reinforced in the post-war period. It is clear that our military-industrial complex requires increasing levels of intellectual capabilities as well as an understanding of science and technology. The practitioners of the futuristic art have already heralded the need for the extension of these more technical skills in order for our nation to enter tomorrow's meaningful community of humanity.

The above causes have, in turn, had their effect on higher education. Their early manifestations were the stress upon excellence in education through excellent teachers and excellent students. Our universities directed their changes towards tougher academic entrance standards for their professorial staff as well as for students. They initiated and maintained more academic specialization, especially at the graduate levels. Qualitatively, the faculties emphasized depth knowledge; quantitatively, the faculties increased the scope and amount of reading expected from their students. Research by individual faculty, individually selected and sponsored by government or foundation grants, prospered until it became relevant to discuss "publish or perish." All of these were the effects of an increased emphasis on excellence as a standard for our community of scholars—student body and faculty. The accomplishment of the sum total of these reforms was that between 1950–1965 our universities turned out over 4 million graduates, which was almost 80% of all college graduates turned out up to 1950.

The quest for excellence in education between 1945–1959 had some negative side effects. Frank G. Jennings stated these as follows:

"They hunted out the gifted child and tried to hound him into competence. They began to rescue physics from the scrawny hand of Newtonian mechanics and cradle it in the nucleus of the atom. They redressed mathematics in properly regal garments, threw away the abacus, and plugged in the computer. They sought good young minds everywhere and found them most often among the well-fed, the well-born, and the fair-skinned." [1]

On the other hand, the quest for excellence in education between 1945–1959 has had, in my opinion, some positive benefits. The first of these was that it provided for education a goal for leadership in our society—to lead it, not follow it. This was succinctly stated by Professor Sterling M. McMurrin as follows:

"Our society is marked by scientific intelligence, social conscience, and an acute historical consciousness; it possesses a remarkable capacity for invention and change. Since for us change is inevitable, unless we move forward with resolution our society is in danger of retrogression and our culture in danger of decline. We cannot live simply by the conservation and perpetuation of the past; we must be critical and creative."

"The proper function of schools, therefore, is to be the chief agents of progress, whether it is the advancement of knowledge, improvement in the arts, technology, or the social conscience, in institutional organization and administration, or in the attainment of those large visions of the future which are the prime movers of history. For the schools, colleges, and universities provide the most effective means for the achievement of the intellectual skill, knowledge, understanding, and appreciation necessary to the analysis, judgment, and decision without which there can be no genuine progress. We depend upon them to stimulate that freshness of ways, attitudes, and ideas which alone can bring vitality and high achievement to a culture." [2]

So accepted has this objective become since the times of Professor Counts' challenging speech that when the American Academy of Arts and Science Commission on the Year 2000 was meeting, there was general agreement with Dr. Herman Kahn's statement:

"Let us assume that it does not take much time or effort to worry about internal order, international order, national security, or material goods. I submit [then] that the main motives of our going to school would then disappear." [3]

As we turn to the 1970s, educators are once again faced with "Dare the Schools Build a New Social Order?" We are aware that a quest for excellence in education as promulgated was at best a short-run objective. The advance of technology in our society already demands all levels of intellectual talent for building the industrial society emerging from the second industrial revolution. The requirements of our "nonroutine industries" as contrasted to the

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[1] Frank G. Jennings, "It Didn't Start With Sputnik," *Saturday Review*, September 16, 1967, p. 97.

[2] Sterling M. McMurrin, "What Tasks for the Schools?" *Saturday Review*, January 14, 1967, p. 40.

[3] Herman Kahn, "Working Session 1: Baselines for the Future, October 22–24, 1965." Richmond, Virginia: American Academy of Arts and Sciences, 1967, p. 674.

"mass production industries" will require over 60% of our productive population in the year 2000, or a work force equal to the 80 million we have today. From a philosophical point of view, Whitehead reminded us a long time ago that: "in the conditions of modern life the rule is absolute. The race which does not value trained intelligence is doomed." Intelligence is not measured solely by intelligence quotient. That was well known to the educator in the 1930s. In today's idiom and in a very pragmatic sense, we can no longer discriminate on the basis of race, color, creed, or intelligence quotient. In economic terms, our nation has an inelastic supply of people to meet their ever-increasing demands. In a philosophic sense, education must enable every person to develop to the fullest whatever he has in him to become. In short, there is no conflict between what so many think are firmly inflexible or polarized needs of our society.

The transition towards these goals will not be easy; yet in some respects it will be much easier than that experienced from 1952–1969. The past five years have seen educators delineate the basic assumptions which will become the base upon which the new and enriched standards for education of the 1970's will be structured. Challenges to seven basic assumptions of the previous generation of educators are being evolved:

(1) *Education is a privilege.*—There is increasing acceptance that education is a universal necessity that has yet to be based on meaningful standards.

(2) *Schools must group, sort, and screen students as to their ability and responsibility.*—There is increasing awareness that schools will accept, stimulate, and nurture each child to find his proper level.

(3) *Education must be separated from the real world.*—There is increasing awareness that there is a broad area of congruence between education's role as a service to society as well as the shaper of society.

(4) *Schools are the only educative force in our society.*—There is increased recognition that schools are not the only educative forces. There are other enterprises, public and private, involved in meaningful education that will be interrelated with the school systems for a lifetime of individual learning.

(5) *Education is exclusively a process by which the older generation transfers relevant knowledge to the younger generation.*—There is growing awareness that much of what the young people need to know for their generation's time today's educators have yet to learn and that there is a growing need to learn more things together.

(6) *The process of learning is essentially a formal process.*—There is a growing awareness that there is a great deal of informal learning outside the classroom. This is evident in mass media, industrial corporation training programs, and military-services training.

(7) *The teaching-learning environment is primarily batch processing involving teacher and students.*—The fear of technological devices (e.g., computers) is being gradually replaced by the growing awareness that these devices are natural extensions for the individuality of teaching as well as for the individual's development of creativity and inventiveness.

In spite of all the above awareness and pressures for change, our principal problem in higher education is widespread, habitual, institutionalized resistance to needed change. My purpose is to discuss some new horizons that provide for the acceptance of change.

The application of systems concepts to all aspects of higher education is still in its infancy. By the same token there has been minimal application from the field of cybernetics to higher education even as an information system. Systems concepts and the other principles are found in all phases of scientific disciplines. Only recently have many of our institutions of higher learning become interested in their application to the university itself. This is only natural, for the emphasis upon a systems methodology has come from both the sciences themselves and the double-barreled major thrust of modern industry's development and recognition of many of our social and economic problems. These thrusts, which in turn have made possible the explorative system methodologies and the creation of principles, techniques, and tools for their partial solution, have provided the main impetus for considering education as an information system.

Higher education's approach in the past, and at the present, has been to do research in bits and pieces and to incorporate the results into the curriculum on a piecemeal basis. When viewed from the application of communication and information principles, such research commingled the data and information so that it covered the need to identify clearly the additions from research to the current state of the art, the advances in techniques or in the processes of teaching, and the advances in the learning process by the student. This method has three significant drawbacks. First, current instructional methodologies are often inadequate vehicles for the transmission of the product of research. Conventional teaching methods in the area of management decisionmaking, for example, do not lend themselves well to the teaching of the newly developed techniques of modeling. Such techniques are best taught in a curriculum where the conversational use of computer is an integral part of the instructional methodology. Second, current modes of curriculum change yield curricula that may have certain outstanding areas; but, when viewed from the perspective of systems analysis, rarely exhibit a coherent structure and are often plagued by inadequacies and redundancies. Third, the time required to transfer the relevant findings of research to specific areas of knowledge and/or technique with the appropriate method of teaching a specific course is so extensive that often it is outdated by newer research before it is utilized.

During the past two years, Dr. Thomas Burke had been Special Research Associate at The University of Texas at Austin and worked on "A Systems Approach to the Planning and Formulation of Technology-Augmented Programs for Management Education." His research resulted in the definition of two main needs in order to develop new curricula and courses using new technology in its teaching by the educator:

(1) An educational approach for the practicing professor who, while perhaps untrained in computer applications for teaching, is seriously interested in upgrading his ability to recognize and put to work improved practices which exploit the full potential of technology such as that provided by the computer.

(2) A curriculum framework or perspective for use by management faculty and/or administration in the identification, evaluation, and incorporation of innovative subject matter into the curriculum.[4]

By now it is clear that systems analysis can be used for the development of integrative curricula. The problem of developing effective curricula relative to teaching resources, research, data gathering, and physical resources suggests an enormous field of inquiry. However, it is the integration of the forces of curricula change, of restructuring our colleges and schools, and of their required resources that is mandatory for tomorrow's society.

III. INNOVATIVE MANAGEMENT UNDER CREATIVE CAPITALISM

When Neil Armstrong took that giant step for mankind, he opened the scene for a better society on planet Earth. Something greater than a step on the moon happened on that historic day. On July 20, 1969, the curtain rang down on the "*First Industrial Revolution*" of the past two centuries and the stage was set for the transition towards an "*innovative socio-technological era.*"

The economic and political success of the United States has been in part due to its "traditional 'capitalistic' [and democratic] factors as sufficient flexibility to accommodate enterpreneurship and a fundamental belief in the value of individual initiative and free competition."[5] Capitalism as a philosophy has gone through at least several phases in the United States. The famous business historian, Professor Norman De Gras, had delineated these phases in terms of "financial capitalism" to cover the period of U.S. business growth from the 1860s to the 1930s and "national capitalism" to cover the period from the 1930s. The first period relied on private capital first from outside the United States and, in later times, to internal United States private financial institutions. The shortcomings of "financial capitalism" led to what many of us in this room lived through as the "Great Depression." The second period was more of a reliance upon federal sources for financing or government guarantees and extensive use of private management. In fact, the major concentration of this second period has been a dramatic partnership between the federal government and private enterprise to prevent the "scourge of depressions." The successes of this partnership in terms of historical "national capitalism" have been legendary. They have made our nation economically affluent and thrust our nation into the forefront of world political powers.

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[4] T. E. Burke, "A Systems Approach to Planning and Formulation of Technology-Augmented Programs for Management Education" (Ph. D. dissertation, the University of Texas at Austin, 1969), p. 130.

[5] Robin Marris, "The Role of the 'Business-Like' Organization in the Technology of Social Change," *Social Innovation in the City,* ed. by R. S. Rosenbloom and R. Marris. Cambridge, Mass.: Harvard University Press, 1969, p. 2.

Success at a national level too often, as at a personal level, lays the seeds for unforeseen possible problems. Today it is clear that "national capitalism" has been deficient in two respects. The first of these is that it has resulted in the United States' creating and exhausting from 40 to 60% of the total world wealth with only 6% of the total population. The second is that national capitalism has, by its very success, dulled our ability to react to the existence—and their timely prevention within the nation—of underprivileged classes, urban crises, pollution, crime, a rising group of lost youths, an emerging new left, and insufficient regard to our more rural areas and their transitional problems into tomorrow's industrial society. In short then, the deficiencies of national capitalism have created the need for what I call "creative capitalism" based on innovative private management.

Today many believe that our social problems are those of crime prevention, pollution, urbanization, poverty, employment of youth, and determination of a stalemated peace. Yet in many respects these are symptoms of the unsolved problems that emerged from an aging, maturing, and declining phase of the First Industrial Revolution. This is not to say that these are not important problems for our present society. They are. However, concentration of a majority of our intellectual resources on these problems to the extent that we ignore those based upon the predictable advances of the Second Industrial Revolution will permit newer problems to arise as continued crises too often wrapped in protest for immediate solution. Such problems of transition were succinctly stated in an editorial of the *Economist:*

"What has happened in France this month ought to nag at the minds of people who are concerned at the way the world's industrial societies are developing. The crisis in France has raised expectations in countries which, though they are rich by the world's standards, are not rich enough to match the rocketing demands of their people. It has also raised the problem of completing the transition from an oligarchic society to a democratic one in a world where efficiency demands that life be organized in large units. These are problems for both communists and democrats." [6]

To this may be added a statement from an editorial which appeared in the June 12, 1968, issue of the Austin *American-Statesman:*

"Our professions, our schools, our fiscal and financial institutions, and all our agencies of government face a double crisis. The demands upon them are increasing in scale and changing in quality at the same time. Only the overhaul and redesign of the institutions themselves can give them a fighting chance to keep pace with the human needs they are trying to meet." [7]

Technology, science, and formal education are not enough, in my opinion, to solve these fundamental needs. The impact of continued automation is familiar to all of us. They range from the concern of human use of the individual to the concern of the continued economic growth of our 500 largest corporations. Mass production two decades ago made it possible to create as the high-income earners the self employed; professional, small businessman, and farmer. Today automated mass production has changed the mix of this group to salaried executives, scientists, engineers, and other professionals.

In short, we are witnessing a relative decline of mass production requirement tasks for employment. The routine requirements of the past two-thirds of this century are rapidly being replaced by machines. To date much of our educational system has been geared to educate and develop people for an industrial society which can be generalized as "routinized" or mass productive.

The task that the last third of the 20th Century industrial state imposes on our educational system is the increasing development of people for nonroutine tasks under "creative capitalism." Particularly since World War II we have seen the rise in what we could call the technological industry, which is concerned with "nonroutinized" kinds of problems and demands that require a new order of solution. These problems are concerned with space exploitation, buildings of megalopolis, control of environment, water and air pollution, marine sciences, crime, transportation, and environmental health.

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[6] *The Economist,* May 25–31, 1968, p. 8.

[7] David S. Broder, "The Need for Institutional Change," *American-Statesman,* June 12, 1968, p. 4.

As stated earlier, these areas provide the bases for an expanding nonroutine industry of the next decade or two. On the other hand, the innovative management is aware that the problems of the Second Industrial or Socio-Economic-Cultural Revolution also provide opportunities. Cybernetics as a science has yet to delineate clearly and specify these opportunities. What are some of these yet unexposed problems that only man can identify as problems?

(1) What will be the 21st Century industries in the United States? How will their development be financed? What will be their markets?

(2) Leisure as an industry is not only in its infancy but is not yet clearly delineated. During the transition to the 21st Century, there will be four types to satisfy the following groups: first, the unemployed (waiting between jobs); second, the low-salaried employees working short hours; third, the higher-salaried groups working short hours; and fourth, the professionals (including statesmen) working long hours and who will have limited leisure in sporadic bursts.

(3) When will a black cease being a black?

(4) How do you redistribute the wealth under "creative capitalism"?

(5) How do you allocate the abundant resources—short run, long run?

(6) How will new forms of organizations change the institutions to fit the social and individual needs?

We have witnessed the advent of technology to newer industries such as nuclear energy, aerospace, and petrochemical and, thereby, have witnessed emerging industries for nonroutine activities. These nonroutine industries have given employment to more people at all levels of our society at a faster rate than possible in the mass-production industries. The nonroutine economic activities are characterized as follows:

1. They are technically based, and their products have a relatively high proportion of technical and professional labor in the final product.
2. There is a continuous shift of the high technical content within the activity from the final product to its tooling or processing.
3. The number of final units is not larger; in fact, it can range from "one of a kind" to what would be generally recognized as a "short production" run.
4. The problems and processes involved can be typified as "messy." That is, there are no single clear-cut solutions including scientific and engineering principles. Often, so-to-speak solutions must be "invented" on the spot.
5. The nonroutine activities thereby utilize large quantities of intellectual capacities; e.g., people ranging from semi-trained technicians and laborers to noted scientists—social as well as physical.
6. The management of these nonroutine activities often requires the full coordination of government, universities, and industry. However it is generally recognized that industry has a major role to play in the economic exploitation of these technological advances.
7. Finally, the ability and capacity of our management of these technological and intellectual resources will determine to a large measure whether our nation will continue to increase its advantages in the nonroutine activities. The reason is that some technologies are more currently available and enjoy a higher probability of success over others; in addition, each has its own costs associated with it in terms of research and development, tooling, product costs, distribution and marketing, service and maintenance, as well as its social costs of retraining, dislocation, and expansion of our urban and rural areas.

There are, however, two underlying requirements to all these "nonroutine" pursuits. First, they demand large quanta of technical and intellectual resources such as individual scientists—social and physical—engineers, and other professionals and service personnel and technicians as aides to the professionals. Second, they require relevant and up-to-date information necessary for the solution of the nonroutine problems. Of course, the key requirement is managers with the ability to identify and formulate the problems for solution.

Any approach we may make for meeting the tasks required for the nonrepetitive problems brings sharp changes in the economic, social, and political environment surrounding the conduct and management of these resources. There are good reasons for this. Our society does realize that our intellectual resources are in short supply. Furthermore, the scarcity of intellectual resources is not only recognized by industry and government but there is an awareness that their supply is relatively inelastic.

In short, technological change has set up a self-amplifying system in its demands for intellectual resources. Technology generates new advancements which, in turn, generate still greater need for sophisticated intelligence and action. The task for management education is not merely to select the gifted or excellent student for training but to develop on a broad front all levels of skills to meet the requirements of society in developing people for all their roles in a society which are essential for the full cultivation of each individual's talents and abilities.

An easy way to summarize the employment needs of our society in the last third of the century is shown on Table 1. (Please note that the data herein are, at best, estimates.)

TABLE 1.—ESTIMATED PROJECTIONS FOR RELATIVE WORK-FORCE REQUIREMENTS EXPRESSED AS PERCENTAGE OF WORK FORCE

[In percent]

	1860	1968	2001
Agriculture	90	10	5
Mass production and service industries	9	70	30
"Nonroutine industries"	1	20	65

The problem for today's education is to develop innovative management that can take intelligent action to solve the cumulative consequences of continuing rapid technological change, economic growth, urbanization, and continuing de-escalation of rural areas in a way that provides for a renewed democratic society in a context of "creative capitalism." Another way of saying this is to repeat the late President John F. Kennedy's call in his inaugural address to confront the "unfinished business of our generation." No rhetoric alone can solve these problems. Nor may it be possible for any one of our 19th Century institutions to solve these problems alone. The 1950s and 1960s saw the growth of a new complex that was instrumental in solving many of our defense, space, and nuclear energy national problems; namely, the Federal government, university, and private enterprise complexes. Their potential problems were clearly stated by the last President D. Eisenhower in his farewall address. The 1970s and 1980s could well see the rise of a broader set of complexes which would include not only the federal government but also local government entities; not only universities but also graduate centers; not only private enterprises as represented in the urban home offices and plants but also in their local plants found in the rural areas supplemented by emerging new firms that utilize the local resources relative to the economic utilization of advanced technology. In many respects, "creative capitalism" can well be institutionalized on these more broader-based complexes.

Creative capitalism must advance our society beyond the need for imperialism or exploitation of people. Creative capitalism's success depends on its creation of wealth in a manner that truly establishes the community of humanity as the goal of our society. Wealth produced under creative capitalism must be distributed in a manner which makes it possible to increase the standard of living of all the people in the world. The new institutions or complexes upon which creative capitalism is based will make it possible to solve in a timely basis our social problems simultaneously while creating wealth and providing for meaningful leisure for all people in the world. Education for creative capitalism thereby provides a challenge as well as an unprecedented opportunity for innovative management of all public and private institutions. Thereby education contributes and receives from experience a continuous process of developing a socio-economic-cultural society while developing the required knowledge of information for transmission to the coming generation.

Knowledge and information for development of innovative management under "creative capitalism" does not exist. In this respect, education today resembles a research and development organization which is geared for change. Professor Albert Shapero described the problem as follows:

"It is almost as if we were now in the position of those who began to develop our present body of management knowledge at the turn of the century We have some skillful practitioners and some artistry, but do not have anything that can pass as an organized body of management knowledge relevant to R & D and the other growing areas of commitment in which technical and intellectual resources play a dominant part. We have a powerful and growing awareness of need for this kind of knowledge in order to cope with the problems that are crowding us now and that can only increase in importance in the future." [8]

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[8] Albert Shapero, "The Management of Technical and Intellectual Resources," Working Paper, Graduate School of Business, the University of Texas at Austin, 1968.

Herein lies the opportunity and needs for education for a changing world. The body of knowledge for transmission lies somewhat in our current materials in basic research of the past and present and in other governmental and industrial institutions although not published or partially published. The education needs are to develop principles of relevances to identify and extend such information. Teaching while developing an integrated body of relevant knowledge is a requirement for which education has no past experiences to fall back on. Simple solutions such as new techniques of multi-media, computer simulation, computer time sharing, and of computer augmentation while advances and often necessary are at best tools that can be used once the body of relevant knowledge is identified. For in the parlance of the computer profession, "garbage in, garbage out." More apropos are the remarks of the famous philosopher Alfred North Whitehead, "that the role of progress is such that individual human being of ordinary length of life will be called upon to face novel situations which find no parallel in his past. The fixed person, for the fixed duties who in older societies was such a godsend in the future, will be a public danger."

The development of the concept of innovative management identification and transmission of data is an example of education in a changing world. Several years ago, I spent endless hours searching through literature for concepts in this field to little avail. Computerization would have helped to reduce the search time but only in the sense that it would have identified a large number of possible books and articles. However my personal acquaintance with H. Igor Ansoff, Dean of the Graduate School of Business at Vanderbilt, quickly reduced the search time, as he has devoted a lifetime to the academic and practical aspects of innovative management. He quickly identified a workable concept that he was developing at the time. More specifically, he stated:

"*Entrepreneurial Planning.*—In this advanced stage, the firm sets corporate objectives, examines its strengths and weaknesses, probes deeply for external threats and opportunities, and—combining all of these—makes a systematic evaluation of its prospects. Any proposals for change undergo intensive search and analysis, culminating in an action decision, which then enters the flow pattern established in earlier stages of planning. Entrepreneurial Planning represents a major commitment of the firm's resources and top management time and can altogether alter the organization and atmosphere of the company.

"This stage-of-growth analysis of management functions suggests several changing roles for the planner as planning evolves in the firm. Further, since the essence of advanced planning is organized entrepreneurship, the planner's job can be viewed as helping to provide the firm—through marshaling its full resources—with the nine types of talent that mark the entrepreneurial genius." [9]

Trying to abstract information on entrepreneurship and principles from the state of knowledge is a difficult task. While entrepreneurship has held fascination for the individual in terms of the American dream of being "in business for one's self," it has also been an area for research and study for over 150 years by economists and social historians. Yet there is little research work published and an extreme paucity of theory of entrepreneurship as it pertains to company formations and growth.

In view of a changing society, it is important that we review the concept of entrepreneurship particularly as it releates to nontechnical company formation and to technical company formation. The contention of this presentation has been that not only are their requirements entirely different but also the trend toward nonroutine industry requires changes in business entrepreneurship as well as changes in all institutions including education that nurture and supplement them. The entrepreneurs who have been interested in nonroutine ventures have characteristics and needs far different than those who are interested in ventures that are more concerned with technological products or services.

It is possible for the professor to develop knowledge together with the student. In the case of entrepreneurship. Dr. Susbauer devoted his effort with a faculty committee to explore the technical company formation process.[10] His doctoral dissertation is an outstanding review of the literature and clearly discloses the lack of knowledge of company formations in both nontechnical and technical companies. There has been little cohesive research in looking for the problems and thereby distilling the principles for intrepreneurship. His thesis showed that specific data could be gathered and maintained on technical company formations in the city of Austin, Texas. However, unless subsequently interested doctoral candidates write their theses in this area, the knowledge so gained will cease as of 1967.

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[9] H. Igor Ansoff, "The Evolution of Corporate Planning," Reprint No. 342, Graduate School of Industrial Administration, Carnegie-Mellon University.

[10] J. C. Susbauer, "The Technical Company Formation Process: A Particular Aspect of Entrepreneurship," (Ph. D. dissertation, the University of Texas at Austin, 1969).

IV. DILEMMAS FACING EDUCATION

At this point we can look more closely at the major dilemmas facing education. The first of these arises from the fact that our educational administrators are truly managers of our society's intellectual resources. These intellectual resources consist of the students who are in inelastic supply and the teachers who will be in scarcer supply because of the increasing future demands by industry and government.

There are today 50 million students in school and they represent 90% of our school-age population. In the next decade there will be 11 million children who cannot read or write; 7 million will not complete high school; and 2 million will drop out before they reach high school. In this next decade 30 million boys and girls will be looking for jobs. Our dilemma is that our educational administrators have to establish the basis for educating the students for an industrial society which is rapidly changing. They do not have the time to analyze the new requirements or establish an integrated curriculum as the students progress from elementary school through higher education. Therefore there are required the means and process for collaboration between the systems of higher and secondary education, between leading scholars and teachers, and between graduate departments and undergraduate departments and the establishment of comparable standards of achievement of students. Finally, channels must be kept open to transfer the flow of technical information and innovation to the students from industry and government.

As managers of our education's intellectual resources, we face the predicament of shortages of teachers. Already we have seen that higher education at the undergraduate level cannot be staffed by full-time tenure staff. Teaching assistants and associates are utilized by most, if not all, universities—public and private. In the secondary schools we are using assistants to teachers for less skilled portions of teaching or giving individual pupils attention. There is a profusion of experiments in team-teaching to utilize scarce teaching resources, in the use of teaching machines and electronic blackboards, and in educational television. There are yet to be adequately developed measures of teaching effectiveness for the last third of this century.

It is appropriate at this time to examine in some detail the use of the computers in education, more specifically business education. It is indeed a shock to realize that the impressive multimillion dollar computational facilities are often than not used to solve the same problems as were assigned under paper and pencil teaching days. Such usages of the computer more often than we like teach the students that they cannot accurately punch a deck of 100 cards after a half-dozen attempts. More surprising is that the problems assigned to the computers often can be solved by the students on today's modern electronic calculators in less than a quarter of the time spent in the modern computer labs modeling, programming, punching cards, debugging, and evaluating the quality of the results.

Since becoming Dean of the Graduate School of Business, at The University of Texas at Austin, I have discovered two concepts which are applicable to computer designers as well as to educators. The first is that both are equally reluctant to use the principles or techniques which they develop. For example, computer designers, as a class, do not like to use computers to design new computers. Nor do educators generally apply the principles of management they teach to their own problems. The second is that both professionals are reluctant to predict the future. Computer designers and educators feel that they do not want to be put in the position to do long-range predictions for they may be held to it.

In industry one quickly learns that a manager has no excuse not to try to predict the future. In fact, the reward system is such that it attaches heavy penalties for errors or omissions; conversely, the rewards for partial success are also high. One cannot start to build a major new company within a five-to-ten year period in the United States without trying to predict the future. Indeed, one cannot enter into the electronic computer industry by extending a current operation or beginning a new enterprise without trying to predict the future. The consequences are evident from following the financial fortunes of G.E. computers, Control Data, and Scientific Data Systems, among others.

No manager will give up his current noncomputerized or semi-computerized formal and informal management system for an untried "quantum jump" of an integrated management information system or "system" management on the computer. On the other hand, I do believe that providing the principles, methods, and technologies as well as the required training for those items which make these concepts relevant is a proper function of the schools of business. In other words, I believe that the schools of business if they are to provide leadership for our business communities must undertake to fulfill these tasks of evolving the future managers for business, including computerized management.

Many tools, techniques, practices as well as experiences exist to help us forecast the future trends and opportunities in the use of computers in business and business education. To make the longer term forecasts of trends in this paper, I have used the information system available to me as a manager and dean. There is no available digital computer, heuristic program, or cognitive processor machine to do the strategic planning required for such a talk today. On the other hand, I have used the results of my industrial computer applications as a base for extrapolations when they are applicable to either uses of today's computers or needs indicated for development of advanced mathematical and nonmathematical techniques, computer devices, as well as research in the better understanding of man-machine system in developing the top management of the future.

The role of computers in the future, in my opinion, is the result of applying current advances in research rather than depending upon startling, unpredictable breakthroughs. By extension of the current state of knowledge and current research efforts in the fields of (1) servo-mechanical control and computation and (2) management sciences or operations research for management planning and control, it is possible to make a number of useful predictions in the use of computers in business and thereby in education.

A useful starting point to establish the basis from which predictions will be made is found in examining trends of the past two decades. Twenty years ago the United States had entered the postwar period of the mid-'40s. The techniques and electronic devices used for purposes of war were being studied for peace-time applications. It was found that servo-mechanisms formerly used to direct anti-aircraft guns could be used for industrial controls—material handling, positioning of machine tools, and semiautomatic process sequencing. A newcomer at that time on the scene, the digital computer could provide a means to mechanize complex manipulative and control problems associated with automation.

By 1960 it turned out that it was not enough to merely recognize that elements of industry could be broken into the parts of a closed loop control system, such as structural units, sensor units, communication units, actuator units, and visual displays. It became apparent that any organic system, of which industry is one type, operated by virtue of something other than just simple feedback. Organic systems had to be examined in terms of the reasons for the functioning of the system. While these principles were set forth by Norbert Wiener in 1948, it took a number of military and nonmilitary systems applications to outline the practical problems of implementation.

Organic system are characterized as manifesting in the broadest sense a form of intelligence. As such, their basic building blocks are people, machines, and their respective interfaces. How these elements are interrelated has been a continuous effort of study on the part of those working on complex systems projects. Most recently attention has turned to the problem of considering the interrelations between multiple weapon systems which must function in close coordination with each other. Here the problem is not one of optimizing any one system but designing sets of weapon systems which adequately assure our national defense posture. In their fundamental respects these studies are closely related to the managerial problems of giving order and significance to those found in some conglomerate industries or in larger national and international corporations.

The modern research in the areas of Management Sciences and Operations Research also dates from the post-World War II period. By 1960 practical applications of early research were being made in both military and industrial areas. However, the advanced research of today is predominantly focused on industrial applications and is being conducted principally in a few of the country's leading universities.

The need to understand the role of the manager in organic systems provided much of the impetus to perform advanced research in Management Sciences.

Accomplishments to date have been significant. Advanced quantitative techniques which are applicable to management decision-making rely on the aid of digital computers. Management Sciences with the aid of computers have solved such problems as location of warehouses or plants scheduling production and inventories, selecting stocks and bonds for investment portfolio, determining the best advertising media for a product, estimating acceptance of new products prior to their distribution, and finally, monitoring and controlling operations of a complex and continuous production systems. Recent thinking indicates that the piecemeal application of Management Sciences to separate aspects of industrial problems is not enough.

One of the major thrusts for looking at organic wholes came from the application of computers to the development of integrated total management information systems. Other current research indicates that even more is required in terms of looking at the problem as an organic whole. By development of computerized total information systems, the interfaces between human decision-making with machines, market requirements, technical confidence in new product development and their successful introduction for a world market became evident. In addition, concepts and methods need to be developed that will enable the procedures to be formed for the establishment of over-all company policy goals and subgoals. Advanced techniques of an analytical nature are required before it is possible to minimize the usual corporate drives which operate through techniques of compromise, conflict, and occasional corporation.

There is work going on in the research laboratory for new methodology on the conceptual level and on computer models as well as various display devices. This is one of the reasons why schools business can play such an important role in the development of computer applications in business. There is need for stating requirements of top management so that they can be executed in meaningful devices that meet the flexible needs of executives.

Research as to how to present meaningful management action reports is required. One cannot help but speculate that some of the actions reports should be given directly to other machines by the computers while others come to management attention. To the best of my knowledge, there is still no truly cross-disciplinary research group for display of information to top management. Schools of business, colleges of engineering, psychology departments, and mathematical departments can help to do basic research in this area. In fact, such cross-disciplinary exchange is a requirement if colleges of business are to extend their training of management for the future through computers. However time sharing for faculty member research is one thing, but time sharing for class purposes is another.

In the future such uses of the computer will be more commonplace in all business and education. The key point is that top management must participate in the total planning of any major projects. They cannot wait for the various functions to bring each of their various alternatives and then try to relate each of these to select a major alternative for coordinating their companies. Model builders cannot build models without working with top management. Otherwise, they will build models that satisfy them. They will be elegant models, but they may not be solutions anywhere near what top management requires. Today management must learn to crawl in the skin of the model builder and the model builder in the skin of the manager. The computer is one tool which facilitates this process. In the future when our schools of business have trained the top management of the future, special staff modelers will cease to be required. Just as operations research groups have begun to be replaced by either becoming parts of the functional group or by taking over operational responsibility, so too will the computer modelers of the future.

The role of the leading business schools is to prepare this new breed of top managers so that they understand and have the know-how to build these computerized models. Our nation is currently in the midst of a management gap as well as an educational gap. Industry, especially the technically based, has developed managers only through limited experience. Their numbers are still too small to be effective in extending our nation's industrial leadership or continuing the rate of growth our companies require. The schools of business are lagging behind industry in this respect. They have yet to have on their faculties scientists, engineers, life scientists, etc., that are found in fair-sized projects in the technically based industries. While it is true there is much talk and excitement on our campuses about cross-disciplinary education in the future, there is little being done. Even when there is such cross-disciplinary education, such as at Texas, we have found that the computer is a bottleneck. A central computer facility for teaching and research becomes quickly over-scheduled, and delays extend for days if not weeks. Waiting for computer runs is not conducive to such cross-disciplinary research and teaching. We at Texas are in the process of establishing a separate computer facility for this class of research and teaching as we start a research project for an integrative curriculum to teach starting in 1975.

Computerized models do not obsolete faculty as is generally assumed. For example, at Texas a model was put into a computer in Los Angeles with terminal boards in Austin. After two days of training the faculty members, one of our current accounting classes used it to evaluate the cost procedures used and their method of estimation. Our production department used it to teach critical path programming. Our quantitative controls department used it for the teaching of chance-constrained programming. Our executive development program used it for teaching strategic planning. Our College of Engineering included it in their engineering executive program. Quite straightforwardly, the classroom use of computers for management training, as most academicians recognize, is in its infancy.

Management of techincal industries and educators of management for these industries, however, cannot continue to wait for required breakthroughs or new curricula. Let me explain why I believe both managers and educators will need to use computers to expand their abilities before 1975 and will need to rely on expanding their conceptual abilities through the use of computers to process large amounts of information for their strategic and tactical decision making. The requirement for such an evolutionary step comes from the rate of technological growth and the resultant explosion of data. As our technology advance continues to increase exponentially, so does our body of knowledge. The university professors are not the only ones who have been publishing books and articles. Members of industry and government have also published profusely. Technical reports published by NASA alone number over 100,000 a year.

Let me try to relate the data explosion to the amount of reading one would have to do weekly in order to keep current with technology through published works. In 1900 the weekly stack of published material would be about five feet high, one foot wide, and one foot long. In 1960, the weekly stack of published materials would be five feet high, one foot wide and sixty feet long. Predictions have shown that by the year 2000 the weekly reading stack will be five feet high, fifteen feet wide, and sixty feet long.

The current trend of computer application to bibliographical search microfilming, microfilm cards, print reading, linguistics and library sciences does help narrow the transference of technical data gap. Even under the most optimistic of claims it does little more than reduce the average search time for managers of technical industries, or their staffs, or the educators of management of technology from one hour a day to perhaps 15 minutes a day. Evaluation of studies made by NSF and Case Institute on what professional people do with their time discloses that the resultant savings of 45 minutes can be used to increase the normal four hours of reading and three hours of work for a normal eight hour day. Microfilms of any sort of computerized retrieval systems do little to reduce the reading time. Abstracts either in small or large print do not solve the managers' problems of extracting the required information for descision making or the educators' problems of extracting the required information for decision making or the educators' problems of teaching, individual research, or determining required research for graduate students.

The diffusion of technology by computers will be an extension of present day data banks and retrieval systems. The use of computers for diffusion of technology will be a step-by-step development. Transfers of technical information will first be done by getting people together from different disciplines and professions to mutually discuss their needs and thereby transmit their research and development results. In other words, it will at first be a "mood" operation rather than a "computer mode" operation, and computers will maintain cognizance of each individual's area of interest in research and development in biomedicine, nuclear energy, defense, space chemistry, etc. Cross-indexing of technical interests at detail levels is not a difficult task. A next step could be that where information is extracted in an orderly fashion by technically trained personnel and filed in computers that are accessible to research and development experts, top management, as well as to educators through time shared computers. Another step would be to establish orderly informational systems for selected areas of technology so that there are acceptable hierarchies of information files that minimize extraction, communication and filing time.

At this point, it is appropriate to review the second dilemma faced by education. Namely, how do we come to grips with the economic and technological considerations in educating for the full development of the abilities of each individual? How do we evolve the education of individuals for both the mass production, repetitive industries and the technological, nonroutine problem industries? How do we bring the resources of the school into full effective use so that each student's capabilities are fully utilized?

One thing is clear: American parents and individuals will not let us say we cannot or we do not know how. We must organize research programs for increasing our teaching effectiveness. Teaching machines and other material technologies are only one means of doing this. Evolving social systems of permitting each student to develop at his own capacity may require provision of a large number of decentralized microfilm libraries. It may even change our methods of grading. The requirements are clear. Policies are fairly easy to enumerate. The implementation is not beyond our abilities, nor must the future of education be projected from present lines of development. In many respects, a simple extrapolation of today's developments would lead to agony. On the other hand, the future must be imagined; and therein lies the ecstasy.

Dr. Bell. Thank you, Dr. Kozmetsky.

Dr. Bell. Our next speaker is Prof. Thomas F. Green, who is professor of education, Syracuse University, and visiting professor of the Harvard School of Education. To give the extraordinary range we have of talents on the panel, and among the speakers, I should tell you that while Mr. Armer was a meteorologist turned computer specialist, Mr. Green is a theologian who has become an educator, and perhaps by being a futurist he joins his theological studies with his education. Perhaps that explains his range of interest.

We are going to have Mr. Green speak on "Education and Schooling in Post-Industrial America: Some Direction for Policy."

STATEMENT OF DR. THOMAS F. GREEN, DIRECTOR, EDUCATIONAL POLICY RESEARCH CENTER, SYRACUSE UNIVERSITY, NEW YORK

Dr. Green. I would like to make two or three comments first. I wish I could be as optimistic as Mr. Kozmetsky is about the capabilities of universities. I cannot be. I want to take a very, very different view than that usually taken of the character of American education in topics that we are dealing with.

Indeed, it may be that this youngest and beardless member of this panel might take in fact the oldest view. Kozmetsky alluded to a talk that George Townes made years and years ago entitled "Dare the Schools Build a New Social Order?"

Just about a year ago I published a rather lengthy exploration into the future of school-community relations and there argued that that question has got to be reserved. It is not an issue any longer whether the schools can build a new social order. They probably can't. They probably never could.

The real issue is whether our social order can build a new set of schools. Let me make one other kind of preliminary comment. I want to talk a little bit later about the character of work, and I must tell you that in doing so I had in mind partly the fact that I thought Peter Drugger would be here. He has said a lot of things about the nature of work in a knowledged society, which is one of those words that is sometimes used to describe post-industrial society.

And that would have been very neat, because then we would have Peter and Paul here. And in any case, I would like to have the Thomas principle, which I am going to allude to, and that is, I think, the point I want to come to, and I want to make it explicit right now, so it gets fixed in your mind, that we may be going into an age in which the entire relationship between education and work has got to be reexamined.

It has been viewed in the past as education as a prelude to work. I would like to suggest that the principle we might keep in mind is that that organization that learns how to arrange its work to develop people rather than people to complete their work will undoubtedly find that its employees are in great demand, and will be offered increasing numbers of positions elsewhere, and that might be in fact the best basis upon which to retain them.

I know as a person with some knowledge of responsibility as an administrator in universities I have followed this procedure and find that I can retain a staff only so long as I can provide them with such startling opportunities that they continually get better offers to go somewhere else.

And there just aren't very many universities that are arranged on that basis, so they say. Now, one last remark in a preliminary way. In other words, what I am suggesting is that the organization work has got to be construed for its educative value, rather than education construed for its value to work.

One last remark that I want to make, because I am coming to the fact that what I put in this paper runs diametrically opposed to most of what is common understanding concerning the changes that are taking place in American education in the last 20 years. I am in fact taking the position which is contradicted by most of the public press and which is in fact contradicted by some of the principal lobby groups for education in this city.

I just simply want you to know that I am aware of that fact, and I am aware of the fact that the point of view I am going to take is contradicted by other positions and I am quite willing to defend it. I think it will stand up. But now I want you to keep in mind there is a very real difference between asking what can we expect to happen and what can we hope to happen, and what will be technologically possible to make happen.

Let me repeat there is a difference between what we can expect, what we can hope for, and what is technically possible to do. We have heard a great deal of discussion that borders on the latter two, what we can hope to accomplish and what is technologically possible. I want to talk about the first, what can we really rationally expect.

Now, on this, before turning directly to the topics that we are asking of this panel, I want to ask one or two really preliminary judgments, and these judgments have to do both with the applications of education in technology, or applications of technology in education, and the impact of technology upon education.

I want to make two very clear-cut judgments. First, it is in my opinion unlikely that the application of technology within the educational system will resolve any major current problem or any problem likely to confront American education within the next 15 years. I simply say this. I will be glad to explain it.

My second judgment is this, that likely developments in technology, however, especially new techniques for the control of behavior, may present the educational system with new problems of structure and content within the next 15 years.

So I am taking as my outer limit the next 15 years. Now, these two judgments reflect the particular understanding of technological diffusion, but more important, they reflect an attempt to keep in mind the difference between what is an educational problem on the one hand, and what is a social problem affecting education on the other.

The first judgment on the applicability of technology within education stems from the following considerations. On the whole, I think it is true that we get widespread adoption of technology in this country only under some combination of three conditions. One, when it is reasonable to expect economic gain of a large magnitude, either for the producer or user or the society; secondly, when it is politically advantageous to adopt or to produce a technology, then the short-run economic gains may be very slight; or third, when it is simply believed, why do you believe it to be necessary to adopt this technology in order to surmount some kind of social crisis.

Economic gains, political advantage or social crisis. None of these conditions, I believe, are currently satisfied in the case of any educational technology that is known to me. Costs are not competitive, running for many school districts as much as 20 times the current per-pupil per day expenditure for instruction.

Now, keep in mind I am speaking here of elementary and secondary education at this point. Thus the economic gain is not evident. Education presents a growing public expenditure, but the size of that expenditure does not increase market behavior in the management of the system.

As a matter of fact, it is mostly tied up in professional salaries. Almost no disposable or manageable reallocation of funds are open to school districts in this country. There are exceptions, but I am talking about and keep in mind that 20,000 school districts.

Moreover, there has been no clear demonstration that the new instructional technologies will permit dramatic gains in achievement. Relative advantages for school systems are not obviously attainable. Gains in motivation and in the enjoyment of learning do occur, but not with enough magnitude to justify the rapid introduction of such technologies, especially when such gains often seem attainable by more conventional and less troublesome means.

The most likely scenario depicting the rapid adoption of instructional technologies is one in which the costs of instructional systems declines, as it will, and their quality improves together with continuing and increasing pressure to raise the level of professional salaries. These factors jointly would produce a crisis of major proportions. It would then become politically advantageous and economically necessary to try every possible device to reduce instructional costs by reducing the number of professionals. All of the conditions for rapid technological diffusion would be met.

There are two points to make. First, the formula for the most rapid adoption of technology within the educational system may therefore be a formula for disaster. Secondly, even if the crisis were met, it is not clear that the result would be desirable for education. Perhaps the word "disaster" is too strong. Such a crisis would be disastrous for the present set of arrangements for education, and that is precisely the point.

We must focus attention not on the possible adoption of technology in education, but on the arrangements necessary if that diffusion is to take place. The application of technology within education will probably occur only when we find new methods of finance, and different ways of representing the public interest in education.

This will require a fresh understanding of how the interests of the profession are to be handled in consonance with the interests of parents, students, and legal authorities. In short, the barriers that stand in the way of a new system of education have to do not so much with issues of educational policy as with the structure of the educational policy, the systematic ways that we relate the public and the profession within the governance of education.

In fact, what produces the crisis is the pressure on professional salaries combined with tax limitations in the conventional outmoded way of financing education. But confronted with that crisis, it would then become politically advantageous.

In other words, it is not at root a technological problem. It is a political problem. But one wants to ask, even so, would the cure be more deadly than the disease? This is the point where questions of good and purpose come into view. Technology is a means, not a goal; but what is problematic in the present educational situation is precisely the goal. The issue is not what is it that will be good for schools, but what is it that schools are good for?

The question that needs asking is whether the goals of policy appropriate to an industrial society can be made appropriate to a post-industrial society. The point at issue is not whether educational technology can provide us answers. It can. But we are in the position of the person who goes to the "answer man." Having found an answer we need to ask, what was the question?

It should be apparent that these observations emerging out of my first judgment about the employment of technology are quite as appropriate to my second judgment about the impact of technology on education. I turn then to consider directly the basic issues.

The social demand for education. By the "social demand for education" I mean the demand for formal schooling. Keep that in mind. I do not mean learning. It is a commonly voiced charge both by students and parents, but often by teachers and administrators as well, that the experiences provided students in the educational system are irrelevant. The charge is difficult to understand, partly because it is often accompanied by the acknowledgment that whether one goes to school or "gets an education" is extremely important. Thus, it seems prima facie that schools and schooling are viewed as consequential even by those most vocal about their irrelevance. And that is ironic. But that observation is really not to the point.

Another reason why the charge is difficult to understand is that is so ambiguous. One wants to ask "Irrelevant to what?" Sometimes the charge has to do with the irrelevance of the schools to formulated goals of personal growth, sometimes to clear-cut vocational objectives. Sometimes the charge of irrelevance is a judgment about the behavior of schools as institutions—both elementary, secondary and universities—either in their internal behavior or in their corporate actions in relation to existing social problems.

They could be more relevant, for example, by providing more jobs for blacks. Sometimes the charge has to do with a judgment about the discourse of educated men, the results of getting an education. This form of the charge is well captured in an observation made at the last meeting of the American Philosophical Association, that when a finger is pointed at an important problem in the world, philosophers will study the finger. The charge of irrelevance is, therefore, not one thing; it encompasses a variety of charges, sometimes personalistic, sometimes programatic, sometimes institutional, and sometimes just the observation that getting an education isn't as beneficial as it might seem.

And that seems a little bit frustrating, when you have been told that it really is all that beneficial. Instead of considering the merits of the charge, I would like to raise a slightly different point. What needs understanding is not the question of fact as to whether schools and schooling are irrelevant or in what respects. Let us simply grant as a fact that they are, and give to the term "relevance" whatever meaning you like. What needs explanation is how that fact can be converted into a significant social claim. Or to put the matter in a slightly different way, from the claim that education is irrelevant, it is meant to follow that something is wrong. Why? How is that made to follow? What's wrong with irrelevance?

Certainly, the relevance or irrelevance of schools and schooling was not a matter much discussed 10 or 20 years ago. Why is it that now anyone would expect schools or schooling to be particularly relevant? I remember that as a boy it was unequivocally pointed out that education is relevant to one's future life chances, but not decisively so. In any case, that was not the point in gaining an education. Some people went on to learn more not because it was going to be especially relevant to anything they would do later, but simply because it was believed to be a good thing to do. In fact, education was often understood functionally to set certain people apart simply because they knew a lot of things admittedly irrelevant. Certainly, there is a strong tradition in America along those lines.

Besides, if one really wanted to pin the tag of "irrelevant" on some institutions in modern America, there are a lot of better candidates than the educational system. For example, the claim that the churches are irrelevant in modern America is a proposition widely accepted, admittedly with different credibility in different regions of the country.

But it is a claim widely accepted even within ecclesiastical and theological circles. Yet that has not been cause for any basic and socially serious complaint on the part of the younger generation. Among those who are ecclesiastically "hooked" that fact has prompted a huge amount of rhetoric and even a degree of intensive, sometimes narcissistic, self-examination. But for the most part, people simply learn to "kick the habit" and they leave. I mean "kick the habit" in many senses. If education is really irrelevant, why don't people kick that habit too? Are they addicted? Is it narcotic?

How can we account for these changes? What are the conditions that seem either necessary or sufficient to render the relevance of schools and schooling a matter for serious thought? (1) One of the necessary conditions is simply that there are a lot of people in schools. It is hard to imagine any putative irrelevance of education to be a serious thing, even for schools, except when there are lots of students in the schools.

Whether schools or schooling are relevant to anything at all is not a problem if hardly anyone is in school. I do not mean that there must be a lot of students in this or that school. There are policy issues concerning the optimal size of an educational institution. But that is not the point. I mean that in order for the relevance of education to become a factor in social policy, there must be a large percentage of an appropriate age group of the entire population in school.

That this condition is not sufficient can be shown by a simple intellectual experiment. Imagine a society all of whose members are in school, all at the same time, but for only 2 days each year. That would clearly satisfy the requirements of the first condition. But whether their schooling is relevant or irrelevant would present no serious social problem. Imagine instead a society in which every child is required to be in school for the entire calendar year, but only up to the age of 8. That would not generate any deep problems of relevance either. What seems to be essential is a circumstance in which (2) a sizable portion of the total population is in school not only for a substantial part of the year, but for an increasingly enlarged span of their lives.

Not even this second condition, however, will be sufficient. There is no a priori reason to deny that the schools of such a society might be quite successful and no problems concerning their relevance need arise. In addition to these two conditions, one might add others. Suppose that such extended schooling takes place in a society confronted with pervasive and basic social problems. Surely, it is hard to imagine issues of educational relevance arising in a society without any grave problems. Suppose further that the management of those problems or at any rate that the questions students ask about these problems are not being raised in the school. That would certainly be frustrating, and it may be that these two conditions are a part of the present scene. However, I would like to emphasize a slightly different point.

What apparently must be added to any list of necessary conditions is a third; namely, that (3) it is widely assumed among those in school—and I should say among those outside of school, because they have got to have got it somewhere—that schools are, or ought to be, a fit instrument for confronting or learning to confront such social problems or for learning to become a better person in the process of confronting those problems.

That is to say, what seems essential to this problem of relevance is the development of a set of expectations about the functions of schools and schooling, about the appropriateness of a certain social fit between means and ends when the school is viewed as the means. Schooling, in short, comes to be viewed instrumentally, and in a powerful way.

It is the combination of these conditions that underlies the issues of educational relevance. Observe what is contained in this particular combination of social conditions. And I will make three points, I think.

1. In the first place, what is involved is the idea that somehow schools and schooling should be made to change rather than the idea so common in the past that because schools and schooling are not particularly relevant, therefore, one ought to leave them and get on to something more useful in life.

Confronted with the irrelevance of education, there seem to be two basic courses of action: (*a*) leave education alone and encourage people to do something else; that would lower the social demand; or (*b*) change the schools. The first course of action will mean abandoning, at least in part, the first of the three conditions necessary for the problem of relevance to arise. The second course of action involves the implicit assumption that education in the formal sense is or can be made a fit instrument for the attainment of all kinds of personal and social goods—a very doubtful proposition, I think.

From the premise that schools and schooling are not particularly relevant, we used to draw the conclusion that one ought to leave the schools and do something useful. Now from precisely the same premise we draw an entirely different conclusion. We now conclude that the schools should be made to change. You can see the relevance of what Dr. Bell alluded to. What I am really saying is, this is kind of a religious belief, that education is basically really the basic American religion. Why is there this difference? Well, there are many, many reasons, but the significant point that I want to make is that the fact that we do incline to draw a fresh conclusion from the same premise provides an operational definition of what we mean by a high social demand for education. The tendency to draw that conclusion, resting upon a strongly instrumental view of schooling, is both what produces a high social demand for education and also what justifies the behavior that expresses that demand; that is, the behavior that translates a demand for education into a demand for schooling.

2. Secondly, consider the following question. Is it possible for a society to satisfy the first two conditions for the problem of relevance to arise—namely, increasing numbers of the population in the school for an increasingly extended period of their lives—and not to adopt the third condition—namely, that education stands in an especially direct means-end relation to the attainment of a wide range of personal and social goods?

It seems to me a reasoable expectation that in any society where the social demand for education is maintained at increasingly higher levels, the issues of educational relevance will arise necessarily, because the only way to maintain that high social demand will be to inculcate high expectations concerning the utility of "getting an education" as opposed to other ways of spending important years of one's life.

In short, the issues of education relevance are symptomatic rather than basic. But they are useful in revealing the basic problems. They arise not because schools and schooling are any more irrelevant than they ever were. These issues may arise simply because we have reached a point of very high social demand for schooling, and because we have reached this point by promulgating an ideology that says education, that is, formal schooling, is good for whatever ails you, and more of it will be even better. That, of course, is a false doctrine—a point to which I shall return.

The essential point to recognize, however, is that the attainment of a high demand for education does not constitute simply a quantitative growth in the educational system. It does not simply represent a commitment to an increase of "productivity" relative to the demand for skills. It represents rather a commitment of the society to a qualitative change. It means, in short, that education will be understood increasingly in instrumental terms, that schooling must be justified in the light of its instrumental value. This is not a new point to American educators, but the intensity of it is new. It is qualitatively new.

3. Thirdly, I wish to make a point that partially retracts the one just made. I said that the only way to maintain a high social demand for education is to promulgate the belief that education will (or should be) instrumentally useful and personally rewarding. There is another way to create the appearance of a high social demand for education. It can be made compulsory. And please note, I say this is the way to create the appearance of a high demand, by making it compulsory.

There are a hundred ways of making education compulsory without direct legislation. Child labor laws are important at the secondary level, and the draft undoubtedly has a huge impact at the postsecondary level. Because of the draft, we do not in fact know how large is the demand for higher education. But more subtle and important are the employment practices and work-organization in business and industry—another point to which I shall return.

For the moment, however, it may be enough to recognize that, however arrived at, an increase in the social demand for formal education experienced as a sequential requirement in the lives of people, may be dysfunctional because in practice, it constitutes an extraordinary extension of adolescence at precisely the time when people are maturing earlier.

It means, among other things, the extended deferment of entrance upon meaningful work. It is ironic, if not downright paradoxical, if not downright tragic, that the application of one's education to socially meaningful tasks should be increasingly deferred at precisely that time when the instrumental promises of education are most vigorously advanced.

The result cannot help but be frustrating and indeed alienating in a society that has promised much to be gained from extended education and then has progressively deferred the reward. When we speak glibly of the decline of the Protestant ethic, we ought to keep in mind that no society has ever placed such great stress on a capacity for deferred gratification, the delayed validation of one's life.

My conclusions are no less paradoxical than the analysis. As we move in America to a postindustrial society, one based upon the cultivation of knowledge rather than craft skills, we shall have to adopt policies that will contribute to a lowering of the social demand for education in the sense in which that demand is currently expressed and experienced; that is, as a demand for increased amounts of schooling in the formal sense offered in a sequential fashion for a long period of time. To this point I shall now turn attention.

So much for education and social demand. I am suggesting the direction of change must be to lower the demand, not increase it; that is exactly the opposite of what is the current direction. Let me divide this into two parts. One is the question addressed to this panel. What about the link between work and education? How might this be changed?

I have already said one thing about it. Let me just raise this kind of question. One wants to ask, where will the essential skills that Dan Bell, Herman Kahn, and others have alluded to? Where will these be developed? Well, there are two alternatives that come to mind immediately. They will be developed in the schools and they will be developed on the job.

If you take the first path, they are developed in schools, then you are going to raise the social demand for education, there will be a very, very strong compelling link in understanding education as a prelude for work. And I don't think that would take us very far.

But in order to make this clear I would like to just outline rather than going into detail; let me just outline one way of getting the grasp of this view. One could take a look at a hundred years of the process of increasing the level of social, educational attainment in the United States.

It is an astonishing thing. Let me just tell you a little bit about what that picture looks like, because it does not look like the picture that George Kozmetsky was portraying. It doesn't look that way at all, because I simply express that growth in a different way than he expressed it.

There has been a steady growth. The most startling achievement in the educational system is in fact the consistent and large amount of proportion of each generation attaining the level of grade 12. There has been steady growth of attainment at the level of grade 12 from about 8 per 100 in 1910 to about 80 per 100 in 1969.

From 1910 to 1968 the number of 18 year olds completing grade 12 has increased at an annual rate of about 1.2 percent. And despite all our talk about dropouts, that has been a steady, steady, persistent rate of growth. At any rate, at that rate, 1.2 percent, the level of attainment at grade 12 by the bicentennial of this country will be 90 percent.

That is, if you think of the bicentennial from the time of the Revolution. Ninety percent of those reaching age 18 will have completed grade 12. It appears to have been an implicit policy of the American people for some 60 years to make education at grade 12 a universal achievement. We are very near the point of attaining that goal.

Expressed in this fashion, the growth of secondary education is reaching its limit. The 90-percent level will probably not be reached, for reasons you can unravel yourself. The implications of this prospect, however, stagger the imagination.

What does the Nation do when the objective of a policy of such long standing nears its attainment? And mind you, no other country in the world has done this. There is something like it in New Zealand, and to some extent in England, but not like this.

So what do we do when we have attained a policy of such long standing? Do we simply seek a more extreme target of the same sort, or do we turn to a new target? Do we simply live with it, or do we set the target higher, and now seek to make attainment at grade 14 a universal achievement?

That is the easy answer. It is also the one most commonly offered. I would like to suggest, however, that such thinking is sort of appropriate to the developing industrial society, in which capital formation and productivity is the main problem.

But in post-industrial society, policy choices will probably have to do more with the problems of distribution than with production. I want to return to this observation later, if I have time, but for the moment I only want to make clear that we can't expect the skills needed in a knowledged society to be produced with a proportionate increase in the numbers of people completing education in grade 12.

All right, how about colleges and universities? What is their capability to provide an ever-increasing proportion of the population with skills needed in a knowledged society? Has higher education, during its recent period of most startling growth, grown relatively to the size of its clientele? I mean, keep this in mind, higher education has grown enormously, but so has the population and so has that age group.

Has it grown relatively to its clientele? If you take the number of B.A. level degrees and the number of high school diplomas, five years earlier you will find that the ratio has been remarkably stable since the 1920's. That ratio, except for some minor disruptions—major disruptions, really, during the war and the depression—has hovered around a figure of slightly less than 30 percent.

In 1967 it was almost exactly where it was 40 years earlier. The proportion of students who are entering and persevere to the first degree, some people think that that is increasing. That more people who enter college are persevering to the first degree.

Actually that hasn't changed since 1920. Let me simply give you one clear reason why. Imagine a college professor who in 1969 has 500 students, and teaches a course which was the same course he taught, say, in 1958 to 500 students. And the 500 students he has in 1968, if they had been there 10 years earlier, would all have gotten A's.

You think in 1968 he would give them all A's? Of course not. His task, among other things, is to discriminate. He does not graduate a higher proportion of qualified students, in fact what he does is he shifts his standards to give the same distribution of grades that he gave 10 years earlier.

In short, what I want to suggest is contrary to some other things that have been said here. One of the social functions of the higher education system in this country is to change its standards in order to maintain a constant ratio between those who enter and those who graduate.

It gets qualitatively better, but you do not expend the proportion. Well, in the paper, I also try to point out that—you know, I make similar observations. And for these reasons, what I am pleading for here is a kind of direction of Federal policy which says that what we really need in this country is the kind of fundamental policy of the sort that was implicitly adopted in the early 1900's, which says that people should be qualified a guaranteed—something like 14 years of education at public expense, but no constraints should be placed upon what sequence they receive it or at what age.

If a man is 50 years old and he has gained 12 years of education, he should be entitled by the society to gain two more. And I would suggest also simultaneously with this that because of the change in character of the secondary system as I have described it, it also is very important that we lower the level, and age level at which youngsters can get their first work permits, and that we perhaps begin to consider that in a post-industrial society, the constraints on learning, which led people to learn, may be powerful enough so that we can begin to remove compulsory education laws altogether.

I hope, starting with grade one and going up. Well, these are some suggestions that are in the paper. I will stop here.

(Mr. Green's prepared statement is as follows:)

EDUCATION AND SCHOOLING IN POST-INDUSTRIAL AMERICA: SOME DIRECTIONS FOR POLICY

(By Thomas F. Green)

I have been asked to discuss a series of questions about the future of American education. What is likely to be the link between education and work? What consequences can we expect from a world-wide movement in which education is conceived virtually as a birth-right? How will access to education be made possible? And for what purposes? These are enormous questions. They cannot be handled in the detail they deserve. Nonetheless, it is possible to gain some perspective on these problems in a way specific enough to suggest some directions for policy. I shall attempt this under three general headings: (1) *The Social Demand for Education,* (2) *Education and Work,* and finally (3) *The Conditions for Functional Literacy.*

Before turning directly to these topics, however, there is one useful preliminary dealing with the applications of technology *in* education and the effects of technology *upon* education. I wish to make two clearcut judgments. First, it is unlikely that the application of technology within the educational system will resolve any major current problem or any problem likely to confront American education within the next fifteen years. Secondly, likely developments in technology—especially new techniques for control of behavior—may present the educational system with new problems of structure and content within the next fifteen years. These two judgments reflect a particular understanding of technological diffusion. But more important, they reflect an attempt to keep in mind the difference between what is an educational problem, on the one hand, and what is a social problem affecting education, on the other.

The first judgment on the applicability of technology within education stems from the following considerations. On the whole, we get widespread adoption of technology in this country only under some combination of three conditions—(1) when it is reasonable to expect economic gains of a large magnitude for the producer and the user or the society, or (2) when it is politically advantageous to adopt a technology even though the short-run economic gains are slight, or (3) when it is widely believed necessary in order to surmount a crisis. None of these conditions are currently satisfied in the case of any educational technology known to me. Costs are not competitive, running for some school districts twenty times the current per pupil per day expenditure for instruction. Thus, the economic gain is not evident. But even if it were, the present structure of school finance will not permit an easy or rapid transition from labor-intensive practices to a capital-intensive enterprise. Education represents a growing public expenditure, but the size of that expenditure does not increase market behavior in the management of the system. Moreover, there has been no clear demonstration that the new instructional technologies will permit dramatic gains in achievement. Relative advantages for school systems are not obviously attainable. Gains in motivation and in the enjoyment of learning do occur, but not with enough magnitude to justify the rapid introduction of such technologies, especially when such gains often seem attainable by more conventional and less troublesome means.

The most likely scenario depicting the rapid adoption of instructional technologies is one in which the costs of instructional systems declines and their quality improves together with continuing and increasing pressure to raise the level of professional salaries. These factors jointly would produce a crisis of major proportions. It would then become politically advantageous and economically necessary to try every possible device to reduce instructional costs by reducing the number of professionals. All of the conditions for rapid technological diffusion would be met.

There are two points to make. First, the formula for the most rapid adoption of technology within the educational system may therefore be a formula for disaster. Secondly, even if the crisis were met, it is not clear that the result would be desirable for education. Perhaps the word "disaster" is too strong. Such a crisis would be disastrous for the present set of arrangements for education, and that is precisely the point. We must focus attention not on the possible adoption of technology in education, but on the arrangements necessary if that diffusion is to take place. The application of technology within education will probably occur only when we find new methods of finance, and different ways of representing the public interest in education. This will require a fresh understanding of how the interests of the profession are to be handled in consonance with the interests of parents, students, and legal authorities. In short, the barriers that stand in the way of a new system of education have to do not so much with issues of educational policy as with the structure of the educational policy, the systematic ways that we relate the public and the profession within the governance of education.

But is the cure more deadly than the disease? This is the point where questions of good and purpose come into view. Technology is a means, not a goal; but what is problematic in the present educational situation is precisely the goal. The issue is not what is it that will be good for schools, but what is it that schools are good for? The question that needs asking is whether the goals of policy appropriate to an industrial society can be made appropriate to a post-industrial society. The point at issue is not whether educational technology can provide us answers. It can, but we are in the position of the person who goes to the "answer man." Having found an answer, we need to find out what was the question?

It should be apparent that these observations emerging out of my first judgment about the employment of technology are quite as appropriate to my second judgment about the impact of technology on education. I turn then to consider directly the basic issues.

THE SOCIAL DEMAND FOR EDUCATION

By the "social demand for education" I mean the demand for formal schooling. It is a commonly voiced charge both by students and parents, but often by teachers and administrators as well, that the experiences provided students in the educational system are irrelevant. The charge is difficult to understand, partly because it is often accompanied by the acknowledgment that whether one goes to school or "gets an education" is extremely important. Thus, it seems *prima facie* that schools and schooling are viewed as consequential even by those most vocal about their irrelevance. But that observation is really not to the point.

Another reason why the charge is difficult to understand is that it is so ambiguous. One wants to ask "Irrelevant to what?" Sometimes the charge has to do with the irrelevance of the schools to formulated goals of personal growth, sometimes to clear-cut vocational objectives. Sometimes the charge of irrelevance is a judgment about the behavior of schools as institutions—either in their internal behavior or in their corporate actions in relation to existing social problems. They could be more relevant, for example, by providing more jobs for blacks. Sometimes the charge has to do with a judgment about the discourse of educated men, the results of getting an education. This form of the charge is well captured in an observation made at the last meeting of the American Philosophical Association, that when a finger is pointed at an important problem in the world, philosophers will study the finger. The charge of irrelevance is, therefore, not one thing; it encompasses a variety of charges, sometimes personalistic, sometimes programmatic, sometimes institutional, and sometimes just the observation that getting an education isn't as beneficial as it might seem.

Instead of considering the merits of the charge, I would like to raise a slightly different point. What needs understanding is not the question of fact as to whether schools and schooling are irrelevant or in what respects. Let us simply grant as a fact that they are, and give to the term "relevance" whatever meaning you like. What needs explanation is how that fact can be converted into a significant social claim. Or to put the matter in a slightly different way, from the claim that education is irrelevant, it is meant to follow that something is wrong. Why? How is that made to follow? What's wrong with irrelevance?

Certainly, the relevance or irrelevance of schools and schooling was not a matter much discussed ten or twenty years ago. Why is it that now anyone would expect schools or schooling to be particularly relevant? I remember that as a boy it was unequivocally pointed out that education is relevant to one's future life-chances, but not decisively so. In any case, that was not the point in gaining an education. Some people went on to learn more not because it was going to be especially relevant to anything they would do later, but simply because it was believed to be a good thing to do. In fact, education was often understood functionally to set certain people apart simply because they knew a lot of things admittedly irrelevant. Certainly, there is a strong tradition in America along those lines.

Besides, if one really wanted to pin the tag of "irrelevant" on some institutions in modern America, there are a lot of better candidates than the educational system. For example, the claim that the Churches are irrelevant in modern America is a proposition widely accepted, admittedly with different credibility in different regions of the country. But it is a claim widely accepted even within ecclesiastical and theological circles. Yet that has not been cause for any basic and socially serious complaint on the part of the younger generation. Among those who are ecclesiastically "hooked" that fact has prompted a huge amount of rhetoric and even a degree of intensive, sometimes narcissistic, self-examination. But for the most part, people simply learn to "kick the habit" and they leave. If education is really irrelevant, why don't people kick that habit too? Are they addicted? Is it narcotic?

How can we account for these changes? What are the conditions that seem either necessary or sufficient to render the relevance of schools and schooling a matter for serious thought? (1) One of the necessary conditions is simply that *there are a lot of people in schools*. It is hard to imagine any puntative irrelevance of education to be a serious thing, even for schools, except when there are lots of students in the schools. Whether schools or schooling are relevant to anything at all is not a problem if hardly anyone is in school. I do not mean that there must be a lot of students in this or that school. There are policy issues concerning the optimal size of an educational institution. But that is not the point. I mean that in order for the relevance of education to become a factor in social policy, there must be a large percentage of an appropriate age group of the entire population in school.

That this condition is not sufficient can be shown by a simple intellectual experiment. Imagine a society all of whose members are in school, all at the same time, but for only two days each year. That would clearly satisfy the requirements of the first condition. But whether their schooling is relevant or irrevelant would present no serious social problem. Imagine instead a society in which every child is required to be in school for the entire calendar year, but only up to the age of eight. That would not generate any deep problems of relevance either. What seems to be essential is a circumstance in which (2) *a sizable portion of the total population is in school not only for a substantial part of the year, but for an increasingly enlarging span of their lives.*

Not even this second condition, however, will be sufficient. There is no *a priori* reason to deny that the schools of such a society might be quite successful and no problems concerning their relevance need arise. In addition to these two conditions, one might add others. Suppose that such extended schooling takes place in a society confronted with pervasive and basic social problems. Surely, it is hard to imagine issues of educational relevance arising in a society without any grave problems. Suppose, further that the management of those problems or at any rate that the questions students ask about those problems are not being raised in the school. That would certainly be frustrating, and it may be that these two conditions are a part of the present scene. However, I would like to emphasize a slightly different point.

What apparently must be added to any list of necessary conditions is a third, namely that (3) *it is widely assumed among those in school that schools are, or ought to be, a fit instrument for confronting or learning to confront such social problems or for learning to become a better person in the process of confronting those problems*. That is to say, what seems essential to this problem of relevance is the development of a set of expectations about the functions of schools and schooling, about the appropriateness of a certain social fit between means and ends when the school is viewed as the means. Schooling, in short, comes to be viewed instrumentally.

It is the combination of these conditions that underlies the issues of educational relevance. Observe what is contained in this particular combination of social conditions.

1. In the first place, what is involved is the idea that somehow schools and schooling should be made to change rather than this idea so common in the past that because schools and schooling are not particularly relevant, therefore, one ought to leave them and get on to something more useful in life. Confronted with the irrelevance of education, there seem to be two basic courses of action—(a) leave education alone and encourage people to do something else, or (b) change the schools. The first course of action, will mean abandoning, at least in part, the first of the three conditions necessary for the problem of relevance to arise. The second course of action involves the implicit assumption that education in the formal sense is or can be made a fit instrument for the attainment of all kinds of personal and social goods.

From the premise that schools and schooling are not particiularly relevant, we use to draw the conclusion that one ought to leave the schools and do something useful. Now from precisely the same premise we draw an entirely different conclusion. We now conclude that the schools should be made to change. Why is there this difference? Well, the reasons are many, but the significant point that I want to make is that *the fact that we do incline to draw a fresh conclusion from the same premise provides an operational definition of what we mean by a high social demand for education.* The tendency to draw that conclusion, resting upon a strongly instrumental view of schooling, is both what produces a high social demand for education and also what justifies the behavior that expresses that demand, *i.e.*, the behavior that translates a demand for education into a demand for schooling.

2. Secondly, consider the following question. Is it possible for a society to satisfy the first two conditions for the problem of relevance to arise—namely increasing numbers of the population in the school for an increasingly extended period of their lives—and not to adopt the third condition—namely that education stands in an especially direct means-ends relation to the attainment of a wide range of personal and social goods? It seems to me a reasonable expectation that in any society where the social demand for education is maintained at increasingly higher levels, the issues of educational relevance will arise necessarily, because the only way to maintain that high social demand will be to inculcate high expectatons concerning the utility of "getting an education" as opposed to other ways of spending important years of one's life.

In short, the issues of educational relevance are symptomatic rather than basic. But they are useful in revealing the basic problems. They arise not because schools and schooling are any more irrelevant than they ever were. These issues may arise simply because we have reached a point of very high social demand for schooling, and because we have reached this point by promulgating an ideology that says education, *i.e.*, formal schooling, is good for whatever ails you, and more of it will be even better. That, of course, is a false doctrine—a point to which I shall return.

The essential point to recognize, however, is that the attainment of a high demand for education does not constitute simply a quantitative growth in the educational system. It does not simply represent a commitment to an increase of "productivity" relative to the demand for skills. It represents rather a commitment of the society to a qualitative change. It means, in short, that education will be understood increasingly in instrumental terms, that schooling must be justified in the light of its instrumental value. This is not a new point to American educators, but the intensity of it is new. It is qualitatively new.

3. Thirdly, I wish to make a point that partially retracts the one just made. I said that the only way to maintain a high social demand for education is to promulgate the belief that education will (or should be) instrumentally useful and personally rewarding. There is another way to create the *appearance* of a high social demand for education. It can be made compulsory. There are a hundred ways of making education compulsory without direct legislation. Child labor laws are important at the secondary level, and the draft undoubtedly has a huge impact at the post-secondary level. Because of the draft, we do not in fact know how large is the demand for higher education. But more subtle and important are the employment practices and work-organization in business and industry—another point to which I shall return.

For the moment, however, it may be enough to recognize that, however arrived at, an increase in the social demand for formal education experienced as a sequential requirement in the lives of people, may be dysfunctional because in practice, it constitutes an extraordinary extension of adolescence at precisely the time when people are maturing earlier. It means, among other things, the extended deferment of entrance upon meaningful work. It is ironic, if not downright paradoxical, that the application of one's education to socially meaningful tasks should be increasingly deferred at precisely that time when the instrumental promises of education are most vigorously advanced. The result cannot help but be frustrating and indeed alienating in a society that has promised much to be gained from extended education and then has progressively deferred the reward. When we speak glibly of the decline of the Protestant ethic, we ought to keep in mind that no society has ever placed such great stress on a capacity for deferred gratification, the delayed validation of one's life.

My conclusions are no less paradoxical than the analysis. As we move in America to a post-industrial society, one based upon the cultivation of knowledge rather than craft skills, we shall have to adopt policies that will contribute to a lowering of the social demand for education in the sense in which that demand is currently expressed and experienced, i.e., as a demand for increased amounts of schooling in the formal sense offered in a sequential fashion for a long period of time. To this point, I shall now turn attention.

EDUCATION AND WORK

Among the questions addressed to this panel, it was asked how might the link between work and education be expected to change? An answer can be formulated by asking where, in the knowledge society, will learning be acquired? Where will essential skills be developed? Two alternatives come immediately to mind. Skills will be developed in schools; and skills will be developed on the job. Undoubtedly, what in fact occurs will be a combination of these two. The first alternative is the usual response. If the chief characteristic of the knowledge economy is that it requires not craft skills, but knowledge based skills, then formal education becomes strategic. This alternative requires a strong link between education and work and undoubtedly an increasing social demand for education in the sense just discussed. There is reason to believe that this path will not take us very far. The second alternative requires a different understanding of work in the life-cycle of the individual, a different view of the organization of work, an enlarged understanding of where education takes place, and a weakening link between schooling and work. This seems the more promising alternative and one that is actually occurring.

Consider the grounds for these judgments. First, let us take a brief and startling look at the development of educational attainment in the U.S.—elementary, secondary, and higher. Secondly, let us examine the implications for work in a knowledge society. Perhaps the most startling achievement of the American educational system is the consistent enlargement in the proportion of each generation attaining the level of grade twelve. There has been a steady growth of attainment at this level from about eight per one hundred in 1910 to about 80 per one hundred in 1969. From 1910 to 1968, the number of eighteen year olds completing grade twelve has increased at an annual rate of about 1.2 percent. At that rate, by the two hundredth anniversary of the Republic, 90 percent of those reaching age eighteen will have completed grade twelve.

It appears to have been an implicit policy of the American people for some sixty years to make education at grade twelve a universal achievement. We are very near the point of attaining that goal. Expressed in this fashion, the growth of secondary education is reaching its limit. The 90 percent level will probably not be reached. The implications of this perspective stagger the imagination. What does a nation do when the objective of a policy of such long standing is near attainment? Do we simply seek a more remote target of the same sort, or do we turn attention to a new agenda? Having built the house, do we simply live in it? Do we set the target higher and now seek to make attainment at grade fourteen a universal achievement? This is the easiest answer; it is also the one most commonly offered. I would like to suggest, however, that such thinking is the sort appropriate to a developing industrial society in which capital formation and productivity is the main problem. But in the post-industrial society policy choices will probably have more to do with problems of distribution than with production. I shall return to this observation in the final section of this paper. But for the moment, I wish only to make clear that we cannot expect the skills needed in the knowledge society to be produced by a proportionate increase in the numbers of people completing education at grade twelve.

Perhaps, therefore, we can expect the colleges and universities to provide an ever-increasing portion of the population with the skills essential in the knowledge society. It is not easy, however, to make the record of the past justify such a view. Over the past twenty years, higher education has expanded enormously. But so has the population in certain age groups, and so has the number of people completing high school. Has higher education grown relative to the size of its prospective clientele? That is the more meaningful test of growth. If we relate the number of BA level degrees to the number of high school diplomas five years earlier, we will find that the ratio has been remarkably stable since the 1920's. That ratio, except for disruptions of war and depression, has hovered around a figure of slightly less than thirty per cent, being in 1967 almost exactly where it was forty years earlier, in 1926.

It is widely believed that greater proportions of students who start higher education are persevering to the first degree. The fact is, however, that during the period of most rapid growth in higher education, the ratio of completions to starts has been remarkably constant, that proportion is approximately 55 percent and has remained so since the 1920's with deviations during the war years and during the depression. It is easy to describe one reason for this stability in the educational system. Imagine a college professor who in 1968 had 500 students all of whom would have qualified for a grade of A in the same class ten years earlier. Can anyone honestly believe that the professor would give them all A's? Of course not. His task, among others, is to discriminate. He does not graduate a higher proportion of qualified students. Instead, he shifts his standards to give the same distribution of grades that he gave ten years earlier. In short, one of the social functions of the college and university system as it currently operates is to maintain a constant ratio between the numbers of those who start and the numbers who graduate, *no matter how many students may come to study.* Academics describe this process as "maintaining academic standards," and they have supported such behavior with an enormously powerful ideology. In fact, it is not a process of maintaining standards. It is a modification of standards in order to maintain a constant ratio between starts and completions.

It might be supposed that higher education has grown because an increasing proportion of high school graduates are seeking a four year degree. There is some evidence to support this view over the long run, but during the recent period of 1950 to 1969 the change was far from staggering. In 1939 first year enrollments in higher education were 34 per cent of the high school graduates of a year earlier. In 1968 the figure was 61 per cent. So over such a long period, the growth is substantial. But during the more recent period from 1954 to 1968 the rate of entry fluctuated mostly from 51 to 54 per cent. So not only is the rate of completions understandably stable in the college and university system, the rate of entry has also been remarkably stable.

This brief picture of the growth of educational attainment must be viewed with certain reservations. In the first place, in the rate of entry as well as in the rate of completion in higher education, some upward turn is detectable in the most recent observations. We do not know, however, to what extent these recent signs of change may be due to the Viet Nam war and to the draft. But probably, the growth is more gradual even than I have described and the stabilities in the system even more intractable. Secondly, these most recent tendencies may be partly due to the enactment of the Higher Education Act and subsequent legislation the consequences of which would not yet appear in these figures on attainment. Finally, I have omitted mention of the growth of the Junior Colleges and Community Colleges. The development of these institutions is recent. Still, some hunches can be made as to their effect. They have grown to the point where they now represent one-third of all initial enrollments in four-year degree programs. It is not clear, however, that this growth represents an increase in the proportion of high school graduates seeking higher education. It may be instead that we have provided an alternative path for securing the first two years of college without, in the process, expanding the system to reach a greater proportion of the potential public. The remarkable growth in higher education has been barely enough to keep pace. It has not stemmed from a new beneficence and public spiritedness of colleges and universities. It has been a consequence primarily of the age distribution in the population together with the extraordinary growth of educational attainment at grade twelve. I do not mean to minimize what has been achieved, but neither should we overlook the remarkable stabilities in the system of higher education and expect it to simply expand to serve ever larger segments of the population and ever expanding needs for schooling.

What do these observations mean for the development of the knowledge society and the organization of work within it? If technical competence is to increase throughout the society in the decades ahead, how will it be done? Where will people acquire the knowledge to apply to the organization and conduct of work? Since we cannot expect a greatly increased proportion of the population to complete high school, we cannot therefore expect the increase of knowledge skills to occur through quantitative gains in that sector. And if the stabilities that I have described exist in the system of higher education, then we cannot expect substantial quantitative gains from that quarter, *unless we can find ways to change the behavoir and indeed the structure of the higher education system.* As a member of the university community, with an intense interest in trying to understand it, I think I can assure you however that change of the type needed will be about as easy to bring about in universities as it would be in organized religion.

There remain two major sectors where change might be made to occur. On the one hand, we could probably make sizeable gains in the *quality* of education at the secondary and undergraduate levels. That might constitute an interesting and useful increment in the skills available to society through the total population. Indeed, this is precisely the point in recognizing that the problem for the knowledge society is not so much production as it is distribution. The fruitful direction for policy is not toward increases in the levels of education attainment. Educational attainment is not a concept that describes what people learn. The focus of policy must be on narrowing the inequities of quality between schools. It must be recognized, however, that *some discrepancies in quality is the price that we have paid, and will continue to pay, for growth in the levels of educational attainment. What must be examined is the trade-off between these two sets of objectives.*

On the other hand, it is possible to seek growth in education totally outside the formal educational system. It is not necessarily a loss to society that about half of those who start in a four-year degree program do not finish. We can seek a vast increase in the number of non-degree programs, an expansion in education for adults at all stages of their lives, and a multiplication of proprietary schools that educate for specific skills. We can learn to appreciate the educational advantages of programs operated under the poverty program and seek to make more useful the vast educational resources of the Armed Forces. That is to say, in the decades just ahead, probably the greatest increment in the level of knowledge skills available in American society will have to stem from non-degree programs of an enormous variety or through degree programs begun, but not completed.

We must keep in mind that the post-industrial society is likely to require an enormous expansion in learning—not necessarily in education. And not for a few short periods of time, but for many. What it will require is not degrees, but skill. The two should not be confused. The educational system does not seem the most promising direction in which to seek an answer as to how that can be done. It will probably be done best through many forms of education outside the formal system of schooling.

The growth of education outside the formal system has probably been the most significant change in education over the years just past. Current estimates at the Educational Policy Research Center at Syracuse indicate that in the United States, in the current year, more people will be receiving instruction of a formal sort outside the formal educational system than within it. The view that education for the knowledge society will be carried on only in schools and colleges represents simply an outmoded view of the way we cultivate learning. What is needed is a view of the *educating* system of American society as opposed to its educational system, and that educating system will have to include the places where work is done. We need to view preparation for work and even the execution of work itself as part of a single process whereby the skills of the knowledge worker are stretched. Work itself will need to be organized for its educative value instead of organizing education for its value to work.

It is, after all, the underlying principle, indeed, the very idea of a knowledge society, that a man's marketable skills are no longer tied to a specific set of tasks within one organization. Knowledge skills are the result of years of diverse training and practice. They are polyvalent; i.e., applicable to an enormous range of tasks. The consequence is that the worker need no longer remain captive to a single work situation; he can market his talents in a broader sphere. Consequently, as the worker becomes more competent in his capacities, he also will become less attached to the specific organization that employs him. Thus, the organization must learn to exist for the man, and not the man for the organization. Those businesses, industries, and work organizations which fail to understand this shift and which, as a consequence, set up blocks to advancement and under-utilize the talents of their personnel will have to face higher levels of personal frustration, the mad rebellion that comes from smashed hopes and the enervating results of defeated expectations.

Thus, a viable organization will arrange work to develop the capacities of people rather than simply use the capacities of people to accomplish the work. Think what that means! It means, among other things, the growth of serial careers. One of the best ways to guarantee the continuing development of people is to permit them access to different careers, even careers for which they are not well prepared. For example, there is no rational defense for the view that competent people should be excluded from teaching simply because they lack the professional degree. Similar judgments can be made for enormous numbers of so-called career patterns. The usual standards for admission into the guilds of the academic world are similar in function to the standards for admission into the guilds of labor and the other professions. They are based on a principle of exclusion. The purpose is to exclude incompetents. Obviously, such devices do not succeed very well. But the point is that they ought to be based on a principle of inclusion. Their purpose should be to draw in those who can perform. The result would be to encourage multiple careers.

The converse principle is equally important. Obviously, if there are multiple paths for acceptable entry into different careers, then there are also graceful exits. I suppose there is not a career path in any area of work that does not have people who would be better off doing almost anything else. They are usually the bitter ones, frustrated by reaching a dead end, possessing unused talents, blocked in advancement, and atrophied in their capacities. A graceful exit to another career would often be a welcome relief. Surely it would be a blessing to the vigorous, as yet undefeated, eager, and competent younger generation on the rise. Surely there is nothing more damaging to the human spirit than the knowledge—or belief—that one's capacities are unused, unwanted, or expended in something of no particular value. Who knows what human misery would be relieved and what human energies released if the possibility of multiple careers were the rule, and if there were, as a consequence, ready means of entry and exit to and from new avenues of work.

The principles of this scenario are not difficult to unravel. I shall not do so except to point out the underlying relation to issues raised earlier. The basic principle is to see education not as preparation for work any more than work is seen as the arena for education. This will mean a strengthening of the relation between work and education, but a weakening of the social demand for education in its present form. The more comprehensive unity of these observations will be clearer if we attend to the final items in this discussion—the conditions for functional literacy in the future.

THE CONDITIONS OF FUNCTIONAL LITERACY

"Functional literacy" is usually defined as a minimal level in the skill to read. The failure to attain functional literacy in this sense is still a critical limitation on the lives of many people in the United States. By "functional literacy," however, I mean to refer to other capacities, those that appear to be essential for an individual to attain a validated life in modern America. They include sometimes more than a minimal capacity to read, and sometimes less. Those conditions can be made clear by establishing their relation to some rather specific proposals for the direction of educational policy. In relating these proposals to the idea of functional literacy, I am following the lead of Professor Manfred Stanley of Syracuse University in a brilliant working paper he has prepared for The Educational Policy Research Center at Syracuse.

Suppose we take seriously the most pervasive and at the same time most fundamental of our intentions in educating the young. Suppose we view the process as directed at the individual, a process of growing up in which the objective is to enable the individual to compose as it were a human life organized around a story that is his own, assembled around a variety of plots and subplots of experiences which define his history. It follows that our intention should be to maximize the opportunities of the individual in certain ways that require structural and economic arenas for his action. We might conceive of the public, and the life of any individual in that public as the passage from one organized theater of action to another.

Given such a view, there are three particular kinds of opportunities that need to be stressed. First, the individual must be provided an opportunity to start over, that is to retreat from the direction that one's life has taken and to seek a new direction, the opportunity to follow a path and then to retreat to pursue another. I have spoken of the emergence of serial careers and the way that that development modified the relation between education and work. This development is particularly germane to this first fundamental kind of opportunity. But there are at least two characteristics of the current educational picture that stand in the way of this development. The first is the assumed relation between education and work according to which education is viewed as the prelude to work. The second is the fact that increases in education are assumed to have to occur in a sequence that is irreversible. That is, each level of education in the formal system presupposes passage through the immediately preceding level. Thus, it is practically impossible for a person to drop out of the educational system for a period of time and then re-enter it at a so-called higher level.

The second condition that seems to me essential is to provide the individual with some structural capacity to retreat periodically from a productive role in the society and to reassess his life. This might take the form of a capacity to claim from time to time some of the benefits of retirement before the time of retirement, a capacity for a "moratorium" with the expectation of returning to productive life perhaps in some new way. There are specific steps that can be taken in this direction. We should observe also that if it becomes possible to attain certain economic goals in the United States with a smaller employment of the total labor force, then one way to meet this possibility is to redistribute the work not among different people, but between different periods in the lives of individuals. For this opportunity to become real, we must have an educational system with much more open avenues for entrance and exit at a greater variety of ages and levels.

A third condition for what I would call "functional literacy" is the demand, at different stages of life, to play a role that is validating for the individual as a participant in the society. The meaning of this condition will be clearer if we pay some attention ot the treatment received by that part of the population currently included in so-called special education.

The categories of special education are variously designated—the handicapped, brain damaged, retarded, exceptional, emotionally disturbed, feeble-minded, etc. These terms usually receive either a legal-medical definition or a statistical definition. That is the way that they are defined for the profession and for the public generally. But the social meaning of these definitions, the way the marks of membership are handled in the society, is much less antiseptic and much less morally neutral. On the whole, the social definition of special education is that it deals with those people who, for one reason or another, are either useless, ugly, or strange.

The criteria used professionally to define the population of special education are not easily extended to new populations. But the social stigmata that accompany these definitions can easily be extended to new populations. People can be useless, ugly, and strange without having any of the medical-legal infirmities that currently would designate them as warranting special treatment. Why are not the elderly, the occupational obsolescent, the racially abused also included in the field of special education? Our educational system, and indeed, our social system, tends to exercise with respect to these populations the same kind of custodial and sometimes even punitive control.

Suppose we imagine the entire educational system as a kind of institutionalized process of auditioning for a set of theatrical roles. What one wants to do is to enter the play on stage and not simply in the audience. We might imagine then two constrasting circumstances in which "show-biz" exists. On the one hand, it can be that there are plenty of roles to go around, but some will go unplayed because there are some whose auditions were just complete failures. For one reason or another, they are not capable. They are the useless people. In short, there can be more roles than there are useful people. But on the other hand, we might have a situation in which there simply are not enough roles to go around for the capable people to fill, more useful people, as currently defined, than there are roles to play. The latter condition would exist, for example, if the adult social roles of the society could be filled only by people of 100 IQ or better. That would mean that 50 percent of the population would fall in the category of "useless" people. I do not think that condition is likely to arise. Indeed, I am not even sure that it is conceptually meaningful. But it illustrates what I mean by the third condition for functional literacy. Such individuals would have no "validated" existence within that kind of society. The provision of that opportunity, for the elderly, the disabled, indeed for everyone, is what I mean by providing the opportunity for societal relevance. There are already large segments of the population for whom that opportunity does not now exist. That population is likely to grow.

Let us ask then, in some final and direct remarks, "Where do these observations lead us?" I would suggest that they lead us precisely in the following direction. We need to move toward a comprehensive national policy that provides for each individual a claim to receive as much as fourteen years of education at the public expense. But this basic intention should be framed so that it does not assume that those fourteen years will be spent consecutively in formal schools, nor should there be any but the most general restrictions at the upper levels as to what the content of that education should be or whether it occurs in schools or businesses. If a man reaches fifty and has claimed only twelve years, then he should be entitled to two more. If necessary his employer should be paid to provide it. If a child chooses to leave school at grade twelve he should be permitted to return to some kind of formal educational program at public expense and if possible at a higher level if he so chooses. Something like this is contained in some features of some proposals for "open admissions" at the college level. But the assumption is not even hinted at that this procedure might be viable for persons in their 30's and 40's or even 60's. The problem is still viewed as a production rather than distributive problem.

Such a direction of change should be accompanied with an initial lowering of the upper age for compulsory education to fourteen, and subsequently with a removal of compulsory education laws from grade one progressively on up. Simultaneously with this we need to move toward lowering the age at which adolescents can undertake their first full-time employment.

The consequences of such measures would probably include the following. In the first place, the social demand for education as it is currently expressed would decline. Secondly, the forms in which education takes place would be greatly expanded. We would move more rapidly in the direction of an educating system rather than the more limited notion of a system of schools and colleges. Thirdly, the attainment of education would be distributed not over longer consecutive periods in the life of the individual, but over shorter spans of time in the entire life cycle of an individual. Fourthly, the human demand to be able to change directions would be greatly facilitated. The reverberations would be felt in every direction.

Dr. Bell. I am sorry that the time did not allow Professor Green to elaborate the last part of the paper. These papers are available outside. I would like to point out particularly because it does have such enormous consequences, that what he is suggesting is that as a matter of national policy, that the Government guarantee 14 years of education, but make it variable, not completely sequential, where a man doesn't have to achieve those 14 years now, but a man would be able to take 14 years at whatever period of time he wants to over his own work cycle.

And I do think it is a very important consideration which can come up in some discussion later on, strictly here without time tomorrow morning to raise that. So I do want to say that it is a very important policy proposal which is being made here, it is very concrete, and specific, and seems to be very important to the problems we have, and I would hate to see that point lost.

So I urge you to get copies of Professor Green's paper, and to read the last section in the detail which it deserves. We have a guest here from Mexico, as we had one before from Finland, who is Prof. Fernando Garcia-Roel, the rector of the Institute of Higher Studies and Technology of Monterrey. We are going to ask him to make some observations on the program, as he has heard it. Professor Garcia-Roel.

STATEMENT OF PROF. FERNANDO GARCIA-ROEL, RECTOR, INSTITUTO TECHNOLOGICO Y DE ESTUDIOS SUPERIORES DE MONTERREY, N. L., MEXICO

Professor **GARCIA-ROEL**. Mr. Chairman, members of the Committee on Science and Astronautics, ladies and gentlemen: It is a great honor to have been invited to be on this 11th meeting of the committee, and to have the opportunity to listen to several most interesting papers and most interesting discussions.

First, let me ask you to forgive me for my poor English. I have never studied your language formally. When I received my formal education, since we did not have computers, I could not predict which foreign language was going to be most needed. It left me with the vacuum of mastering your language and studying other foreign languages.

I have listened very carefully and read very carefully the papers presented by Dr. George Kozmetsky and Dr. Thomas Green. Both papers presented very clearly the role that education should play in your changing economy.

More papers are going to be discussed at this meeting, and my observations could add little to the topics covered. Nevertheless, I feel that my contribution should be to add the view of a person living in a developing country, and the expected similarity of the extreme importance of education.

As a large industrial country, you have to pay attention to the changes in other areas of the world. Your country, the United States, is changing from an industrial country to what you call a post-industrial economy. In a developing country, we have the same or larger pressures on education—to change to the industrial economy.

The main bottleneck of development often is a lack of human resources to do it. I don't mean that this is the only one. It is one of the largest and hardest. Probably this lack of trained personnel, combined with the still incipient process of developing capital resources, are the main factors that control the rate of change.

The first factor can be solved only with increasing the education at all levels. Some changes that took several decades in the modern industrialized countries, we are forced to try to implement them in shorter periods. We are forced to telescope these changes.

Developing countries import from industrial countries some material progress immediately, like much better medical care, that decreases the mortality and increases tremendously the population growth.

Some other forms of modern technology are also rapidly imported, like radio and television. But, like Mr. Wiio mentioned this morning, this creates a window to compare their living with the standards and kinds of living in more advanced regions.

This, of course, brings dissatisfaction and a strong motivation for rapid change in their standard of living. As you can imagine, most of the poor people don't have any idea that eventually the coming generations are going to inherit, together with a better living, the problems that you have to solve now, like pollution, poverty in the ghettos, loss of individuality or leisure time with no useful purpose, like Dr. Boorstin mentioned this morning.

These demands of the people for material progress cause tremendous pressures on the people responsible for directing the changes, either in government or business. These rapid changes also increase the already uneven distribution of wealth. It is common in the developing areas, within the same country, to observe people that still live in inadequate facilities equivalent to those in existence two or three centuries ago, and at the same time to observe other sectors of the Nation that enjoy facilities just like yours.

I have also observed that people keep going to the city to live under unhealthy conditions caused by industrial pollution. It is very interesting to mention also that in this type of city environment, any important ideology, exotic or totalitarian, can find a very fertile ground for subversion.

Everybody is aware that sometimes these exotic ideas can profit from the same motivation for progress of our people. In a world of this type, the responsibility of educators is very great also. Sometimes universities have to be involved at the same time in extension work of a very primitive type, and talk of systems engineering, or buying a new third-generation computer, and helping in the creation of a trade school and organizing at the same time a graduate school of business.

Mr. Kozmetsky said just a few minutes ago that technology generates new advances which in turn generate even greater need for sophisticated intelligence and action. In the developing countries, we also have our change. The need for telescoping the changes in shorter periods generates greater need for using technology in our intelligence with ever-increasing efficiency.

The challenge of education in developing countries is extremely interesting, maybe as interesting as the challenge that the educators have in this country, with one great difference. You can, in a sense, take your time. Only a few people can guess in which direction your society is moving. In the developing areas of our country, everybody wants to move in a definite direction, and the desire and motivation of these people in government and education only have one alternative—get it changed very soon. Thank you.

Dr. BELL. We have a short period of time for questions and discussion. Dr. Noyes?

Dr. NOYES. I would just ask a question of Professor Green. Did I understand you correctly to say that 20 percent of young people are now graduating from college and that that hasn't changed for 30 years?

Dr. GREEN. No. What I said was that if you view—one indicator of the relative growth of postsecondary education would be the ratio between about a level—that figure in relationship to high school graduations of 3 years earlier. And that ratio has not—in 1967 was what it was in 1926. It is approximately the same figure.

May I make one other comment about this in that there are two other aspects to this which are extraordinarily interesting. One of them is that the entrance ratio between high school graduations and those who enter 4-year programs of the next year has also been remarkably stable, but it has shown a recent tendency to rise.

We don't know why. I mean, it has been so recent that you can't really attribute it to anything. Higher education after 65, could be the Vietnam war, could be many things. But it is rather insignificant in the period from 1950 to 1968, because if you view it from 1939 to 1968 it goes from 36 to 61, something like that.

But mostly it really is a period of tremendous expansion in higher education, represents a fantastic achievement of this society; namely, to hold its own. We have just stood still. And in doing so, we have done what George suggested, produced 80 percent of all graduates that were ever produced in this country.

Now, the mere fact that we have maintained those stabilities during this period from 1950 to 1968 is, I think, one of the most extraordinary facts in achievement of this country. But it may be, I am not saying this for sure, I am saying this raises the question as to whether there are stabilities in that system of colleges and universities that part of the educational system, which will make those ratios continue.

If so, then you can expect that there will be a stable proportion of the population from 1975 to the end of the century who have B.A. degrees. It will be about 23, 24, or 25 percent. And it will respond primarily only to demographic changes, not to policy changes.

Dr. Noyes. If you believe Wallace Rhodes, 4 percent of the 22-year-old people, of all the people 22 years of age, graduated in science and engineering, that this fraction has not changed for a long time.

Dr. Green. Yes.

Dr. Noyes. So you are getting them into other fields but you are not getting them into science and engineering.

Dr. Green. That is correct. And this is what gives the impression, then, that you are having severe decline of the enrollments in the areas of the technical fields. It is because primarily, for two reasons. One, we have had, we really have achieved in this country a remarkable attainment of academic achievement at grade 12, you see.

That is really what has driven the growth for higher education. That plus the fact that we have got this bulge in the age group. Well——

Dr. Boorstin. May I ask a question of Dr. Green? I wonder, during this period of stability in numbers, would you say that there has been or has not been a substantial change in the informational and skill content received by the students who have undergone this process?

Dr. Green. Yes; I am glad you asked that, because one of the points I didn't have time to make was that, of course, these stabilities reflect a certain kind of view—namely, one which is based on what we call academic attainment, and academic attainment is not a measure of what anybody learns. It is only a measure of degrees and levels. And you have to keep that in mind.

I am quite sure, from my own personal experience, that we are going to reach a point shortly when grandparents—or parents, for that matter—and we are getting there rather soon, with my kids, anyway—

when the parents are going to say, "Nobody at that age should be that damned smart."

Qualitatively, there have been just extraordinary things that have occurred, and that is where we have to look. This is what I am arguing is that that is the place where we have to look for change.

Dr. BOORSTIN. Could you detail that for us, perhaps, in some specific areas? I suspect you are thinking of mathematics, but what about other areas?

Dr. GREEN. Well, you cannot detail it for the very simple reason that this is a point which is really under study. But you know, you can instinctively say some things, like if you take a look at something like information diffusion process and tried to chart the speed at which certain material starts at the top of the educational system and moves down, you would begin to get an idea of what quality changes have occurred.

For example, over a long period of time you would find calculus being introduced at a level very high, and it is now frequently down at the 12th-grade level. You find Latin being introduced very early. Now it is up, you know, way up in the university. You can probably chart these changes. But to tell you the truth, nobody has done it.

I won't say that. There are two or three books in the history of American education which do it, but they do no more than record sort of the 18th century curriculum, and you know that the record of what was taught even in the universities in the 18th century, the listing of logic, rhetoric, et cetera, just doesn't give you a clue as to what was really happening.

I think it is a major historical investigation that needs to be conducted to trace the speed at which those changes have occurred. And I suspect it is increasing, and that would be a major qualitative change. But you just can't comment on it very well.

ETS has done some work in this area. Sort of like the observation Richard Niebuhr once made about a book his brother did, a book on ethics. He said, well, yes, it's a good book, but it—really, you know, it was all right, but it was not by any means decisive.

And what ETS has done is sort of on the principle that we sometimes follow—namely, if a thing is worth doing, it is worth doing badly. And that was worth doing, and ETS did it, and it is a very, very bad deal. They have done it not very well, but they have done it better than anybody has done it.

Dr. BELL. Could I ask you this, Dr. Green. In trying to understand this constant ratio of completions of college to those of start, you assume that this has been maintained by a subtle shift of the way in which the professors' students, as you put it, maintain academic standards, and that this is one of the mechanisms that you see for the maintenance of this sort.

Would you entertain a possibility that there is a relatively constant distribution of talent or intelligence in the group and this reflects, really the constancy is a reflection of that distribution rather than just a social mechanism to maintain——

Dr. GREEN. Yes. As a matter of fact, that is one of the alternatives, it seems to me, worthy of investigation. And may I just say one more thing, and that is that I think there are two very significant things that must be said about that kind of approach. One is that we have got to learn how to discriminate between intelligence and intellect, because if the issue is what are schools good for, then I think it may be one of the things that universities are really good for, and good at, is the development of intellect, not necessarily intelligence.

And clarity on that, together with some understanding of distribution of something called intelligence or talent, would help us greatly to discriminate between what kind of institution ought to do what.

The other point I want to make is that the same question that you have raised should also be raised with respect to what we have come to call equality of educational opportunity. There has got to be some distribution of attainment, there has got to be some distribution of talent. Some distribution. You can't determine for policy what we mean by quality of educational opportunity on the assumption everybody is going to score on the mean in some national test.

Dr. Bell. Dr. Zucrow.

Dr. Zucrow. I used to teach at Purdue University, and I remember a couple of years ago I asked one of my ex-colleagues: "How are your freshman students these years?" He said, "The best bunch of freshmen we have ever had." Then I find out that at the end of the 4-year period, the percentage that didn't make it is just as high as it was 20 years ago.

So then I looked at the curriculum. I would say the curriculum was taking the master's degree curriculum of 10 years ago. And that had become the undergraduate curriculum. And this is the reason I think they pushed the standards up and up as we push the other one up, so since there is a certain distribution of people who make this kind of curriculum the numbers stay about the same, percentagewise.

Dr. Green. I would only urge upon you the need to consider the human consequences of doing this.

Dr. Zucrow. I am not doing it.

Dr. Green. I know you are not. But I want to make this point. That is what I am concerned about. I think that together with just the assumption that this country will go to an increasingly higher and higher level of attainment is nothing less than inhuman. I think it has consequences for human beings which are damaging, which are alienating, which are distressing.

That is why I insist you have got to have a policy which as long as we live with the idea of education has got a lower level of demand for education. And that means raise the demand for adult education, continuing education, formal education, and all the others.

Dr. Brown. We have been doing a great deal of soul-searching in my own institution, California Institute of Technology, concerning this very question, where I fear that a number of our students or a substantial proportion of our students have gone through a severe traumatic shock as a result of the fact that to maintain the policy, from year one, of maintaining our entering class at the same size, and our total enrollment at the same size, we draw continuously from a larger pool.

The competition is ferocious to get in, with the result the students who enter are virtually straight A students from their high school days. The high schools vary enormously in size and the levels of competition, in which the students have already been involved and the number of students we have knocked out in competitive process remains about the same proportion.

And so by their sophomore year we have had nervous wrecks on our hands. And as a result we have started the policy of not giving any grades at all the first year, and—this happens to have worked extremely well. But I fear we still have to go several steps further, before the situation is solved.

Dr. **Green.** I hope deep links between this topic are maintained, between what we have been talking about now. I hope they will be maintained in our eyes, and what Paul Armer was discussing earlier, what George Kozmetsky was talking about, and some of the principles of that marvelous paper this morning of Dr. Boorstin, because you see, we may have reached the point where we have a self-liquidating ideal, and that ideal is sort of like, I think, the religion of education.

Dr. **Bell.** We will have to come back to this tomorrow. There is here a very coherent problem, which the problem closed on the historical level of the self-liquidating ideals, the challenges of Mr. Armer regarding the way in which people become outmoded so quickly by the demands of technology, the figures of Mr. Kozmetsky on the demands of knowledge and the way in which they are increasing and finally your own statement, Dr. Green, regarding the pressures on students, and some of the political and social consequences of that.

This discussion in part reminds me of an old illustration of a man who has been asked about the future. They say to him, "Are you optimistic or pessimistic?" He says, "Well, I am optimistic," and he says, scowling, "but I don't think my optimism is justified."

(Whereupon, at 4:55 p.m., the meeting was adjoined.)

ELEVENTH MEETING WITH THE PANEL ON SCIENCE AND TECHNOLOGY

THURSDAY, JANUARY 29, 1970

House of Representatives,
Committee on Science and Astronautics,
Washington, D.C.

The committee met at 10 a.m., pursuant to recess, in room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller, chairman of the committee, presiding.

Dr. Bell. This is the last session of the program of the 11th meeting with the Panel on Science and Technology, taking up as our theme the management of information and knowledge. We have had incredibly rich fare these last 2 days, with six full papers plus the introductory keynote speeches of Mr. Bundy and Chief Justice Warren, and the observations of our two guests—from Finland, Dr. Wiio, and from Mexico, Dr. Garcia.

I would like to go ahead quickly this morning in order to save time, since we only have 2 hours, to final comments.

We have two prepared statements by Professor Stancescu of Bucharest, who is councilor of the National Council of Scientific Research; and L. Harvey Poe, Jr., of Washington, D.C. Then let me just see if I can provide some quick setting for our discussion this morning.

The two major papers we had at the beginning, those by Mr. Kahn and by Professor Beer, sketched the major problems ahead as we look at the question of how we manage information and knowledge in the postindustrial society. The papers yesterday raised more specific questions. The one by Mr. Armer raised a problem of the rapidity of change, and the question of how does one, in effect, educate for rapidity of change, particularly when you have computers as the main engine, if you will, as the main tool of the organization of knowledge itself changing so rapidly, and therefore the problem of adapting to this new knowledge becoming a very important one for the society.

Dr. Kozmetsky, from Texas, also raised the question of how does one retrain educators to handle this new knowledge. So you have here the problem of retraining, and the rapidity of change as a major question which confronts us.

The question raised by Dr. Green was almost a contrary one, saying perhaps we are raising too many expectations on the part of those who are coming into the universities, and instead of so easily and blithely giving everybody a guarantee of 14 years and pushing them through school when they may not be able to handle it, let us give them a guarantee of 14 years of schooling, but make it variable, let them come when they want to, and reduce, in effect, the demands of education.

Those are the issues that are before us. There are several others which were just into that tangentially and which did not come to the fore as these issues did. If one is going to have the problem of rapidity of change and information of knowledge there is the question raised by Professor Beer of information overload. How does one cope with the information overload?

Is it simply the growth of more abstract journals, or of more intermediate journals which would mediate between the scientific field and the public? Is this the way of doing it or are there many other ways? He gave a very beautiful illustration of the use of television playback. Is this a way of handling the information overload?

That, too, becomes a question for us. There is a problem that was almost just barely touched upon by Mr. Armer in his paper which raised a crucial question of how does one organize the computer industry, in the sense of public relations? Does one have a computer utility in the sense of the way we have a telephone utility? Do we have a single user, basically, for a computer utility?

Do we have a dual basis for a computer utility? Do we have a complete open system? Do we have a Comsat type system? If the computer utility in the next 20 years is going to be the largest single utility in the country, matching anything we know of the electric utility or of the telephone utility, should we organize some kind of computer utility system?

Is this a valid way of thinking of the computer industry, in utility terms? Now, I am not sure we are able to handle all the questions this morning, but I did want to focus, let's say, on at least four or five major themes which have emerged from our discussions, which have been, in a sense, implicit in them.

On the computer side, the information overload and the problem of the computer utility. On the educational side, the handling of knowledge, the question of the retraining of professors and the problem of slowing down the rate of absorption into the colleges which has been raised by Dr. Green.

That, as I say, is an attempt to sketch some of the questions for discussion this morning. They are not obligatory particularly on the commentators who themselves will be presenting their own notions of some reviews.

Let me turn now to begin first with Professor Stancescu of Bucharest. Professor Stancescu?

STATEMENT OF PROF. IOAN D. STANCESCU, BUCHAREST TECHNICAL UNIVERSITY, AND COUNSELOR, NATIONAL COUNCIL OF SCIENTIFIC RESEARCH FOR RUMANIA

Dr. **Stancescu.** Mr. Chairman, distinguished members of the committee, of the panel, and guest panelists, ladies and gentlemen.

It is a great honor for me to participate in this annual meeting with the Panel on Science and Technology, and I am deeply grateful for the invitation extended to me to take part in your deliberations.

My task today is to summarize some of the impressions I have gained during the last 2 days of proceedings and to comment upon them.

No doubt, my strongest impression is that of the whole concept of the working of the committee and its panel, and the high quality of teamwork involved. By the wise selection of problems of striking and immediate impact, or of long-range effect, presented and discussed by outstanding scientists and guest panelists from inside the country and from abroad, the committee not only opens windows for the direct information of the Congress, but also really opens doors, as was so well expressed here by Congressman Fulton, for worldwide benefit.

I am very happy to have been offered in this way access to the debates on the most interesting problem of the management of knowledge and information. Even if this problem is not so immediately pressing in other countries as it is in the United States, where the involved activities already have reached the gigantic flow characteristic of post-industrial society, by the high rhythm of introduction and progress of computers, these other countries, too, will soon be faced with similar problems.

It is not my intention, nor is it possible in the allocated time limit, to comment in detail on both keynote addresses and all papers. I would like to share this task in an adequate way with my American colleague, Dr. Poe. As we could not find time for an optimum division of comments, he was so kind as to leave to me the natural privilege of the comments from a foreign point of view. So I rely trustfully on him for all the rest.

I will offer my remarks in the order of the agenda of the meetings, and I wish to point out that the selection of the points that I comment upon denotes by no means priority considerations, but only accents laid on aspects with personal resonance.

I quite agree with Mr. Bundy's views and alarm on the endangered environment, as already in my country we have had and continue to have to fight important air and water pollution problems. The high rhythm of industrialization determined in Rumania a great concentration of industries and the erection of big power stations, so that in certain areas we nearly reached the upper limits of air or water pollution or both.

We also have to face heat pollution of water. Several of our existing conventional thermal power stations with installed capacity of over 1 million kilowatts each evacuate too large quantities of heat related to the available cooling flow of the rivers, which, except for the Danube, are but of medium size. This situation will get worse in the future when big nuclear powerplants will appear.

So we have certain examples wherein nature hits back—sometimes in a more direct way as in the rather sophisticated forms in advanced industrialized countries where these influences were built up in time, with no control in the early stages.

As the problem grows rapidly, a priority research program on a national scale was started last year in my country in order to best prevent pollution in the future. Insofar as burdens and costs are concerned, their allocation and distribution between producers and consumers or upon different public sectors cause no difficulties, because these are done from the point of view of the whole economy. Their assignment between present and future generations is a problem which still deserves more consideration.

I am also with Mr. Mundy when he emphasizes that rigorous study and prompt action must derive from national governments. I also see important possibilities for international cooperation and collaboration in urgent environmental tasks. I am sure my country would embark voluntarily in such action, as it always has done for actions in the interest of mankind.

To be frank, I still feel under the visual impact of the concentrated and interesting material displayed by Mr. Kahn. I did not quite recover from the effort of following his brilliant oral exposure delivered here with a higher order of ten. I would only like to congratulate him sincerely and ask if he agrees for the pleasure of more detailed personal comments sometime, as although all are fascinated by the millenium, we still have some time, I think, to prepare for it. So I will turn the comment here completely over to my new friend, Dr. Poe, whom I admire very much for taking notes for that purpose.

I would like to add to the discussion on Professor Beer's paper that I cannot follow entirely his opinion on information expressed even in simplified form, that information is what changes us. Certainly, we change owing to information. But not all information leads to such an effect. The change is an integrated result of the action or lack of action of all information transmitted by data. So what we really need, I think, are data filtered or screened to information, capable or not, depending on its content and our own reaction, to change us. In that vision I would not mind large quantities of data, as far as they can be screened, filtered, selected or even ignored and stored for future, yet unknown needs, as was pointed out by Dr. Whipple.

Regarding the concept of models of esoteric boxes and superimposed metasystems, I can recall how well it works for large electrical macrosystems composed of interconnected networks of several States here in the United States, or of large groups of countries in Europe. Each local system has and keeps its own established inner order and its inertia, but what counts is the general benefit of the well-known technical and economic advantages of interlinked operation including the substantially increased stability of the entire supersystem, as we call it, equal in content to metasystems. Even if many questions are not yet answered as to how this concept will work when human beings are involved, I think it represents a contribution to better investigation and penetration of the complexity of the information management problem and to cybernetic approaches. At the same time, it seems to me to be an anxious human message of great sincerity and deep conviction. We have to be grateful to Professor Beer for having delivered it here.

The debates on the individual, the State, and the machine were opened by the keynote presented by former Chief Justice of the United States Earl Warren. I was extremely pleased to hear the opinion of such an outstanding personality on how computers will interfere in the future not only in the activity of judges, but in many other directions of individual interests.

I completely agree with Dr. Spilhaus' appreciation of Dr. Boorstin's paper. It is really profound and delightful and for me, as a foreigner, of high documentary value. I would like to observe, however, that the so suggestively entitled "Self-liquidating Ideals," are probably exposed to an increasing influence of the dialectical change owing to overgrowth, the change of scale and proportions, and herewith to the new conditions appearing in almost all respects.

Dr. Wiio from Helsinki presented a home image of technology, mass communications and automation problems in Finland and the importance to solve them according to the conditions in his country. He is so well intended in that respect that I am certain that he will be remembered only as one of the builders of the welfare of his country and runs no risk from the pollution problems as this will be somehow mastered in the meantime.

To the thoughtful paper of Mr. Armer, just two brief comments: If we think how people with low education learn to use electric power and telephone service, one has not to be too pessimistic about how people with modern training will quickly learn to use computer power * * * but not before they will appreciate directly its help and advantages. I congratulate Mr. Armer on the formulation of the Paul principle. Most of us felt more or less consciously its ruling. But it deserved a clear formulation and a name, I like, as somewhat predestined.

Education for a changing world is a most attractive item and a fascinating task. The papers presented by Dr. Kosmetsky and Dr. Green raise problems typical of the new development to the post-industrial society in the United States. Rector Garcia-Reel reminded us of the problems specific to the stage in Mexico. I assure you we have to face many complex education problems in my country, too, because of the rapid technological and economic change and development. The discussion did but start yesterday on this item and will surely continue very active. I may add some remarks later.

I am supposed to comment, not to conclude. But I cannot refrain from insisting as a general observation on the high character of the theme of the meeting with the panel, on its well selected items, on the quality of papers and verbal contributions, as well as on the efficient and attractive working style and environment conditions.

At the end of my comments I would like to make a more personal remark. Of course, I have heard and read a lot about your wonderful and interesting country. I have many American friends in the field of science, power and management whom I have met during years in conferences and working sessions over the world. But I really began to understand your country last year on a 2-week lecture visit.

A further most significant step, of a higher grade of magnitude I should say, was accomplished this week when I had the privilege of attending this panel meeting. I have gained a basic insight into the goals, the level, the methods of your work and of the excellent spirit and atmosphere in which it develops. I was also most impressed by the cooperative relationship between Congress and scientists. I applauded, as everyone, the moon landing which I watched last summer on the TV in Bucharest. I understand it better yesterday in the basement of this building at the luncheon of the National Space Club.

I am very happy to have participated in the deliberations of such an outstanding panel, and I deeply hope that the international exchange of scientists, scholars and managers will be one of the positive activities to be rapidly increased in the future.

Thank you for your kind attention.

Dr. Bush. Thank you, Dr. Stanescu, for that very illuminating and incisive summary and comments.

Our second commentator is Dr. L. Harvey Poe, Jr., who has, if you have looked at the biographical sketch, an extraordinary career as mathematician, physicist, political philosopher and lawyer, which at the moment is his present role today.

Dr. L. Harvey Poe, Jr.

STATEMENT OF DR. L. HARVEY POE, JR., FIRM OF HOWARD & POE, WASHINGTON, D.C.

Dr. POE. Mr. Chairman, distinguished members of the committee and the panel, ladies and gentlemen, for the last 2 days we have heard of the increasing complexity of our world, the proliferation of new data, the increasing power of computers, new means of managing information, and, in general, the dangers from, and hopes of, our vast pervasive technology now available to become our slave or our master.

In this complex world, where we must manage or be overwhelmed, the danger is that technology, which we used to consider a docile tool and use as a means, is endangering our freedom of choice by threatening to escape our control, become autonomous and be an end in itself; that is, technology is threatening to deny its maker and no longer serve our chosen ends, but to pursue its own purposes.

It behooves us, therefore, as men, who after God are masters of the universe, to regain control of our creation, not to say our creature, and to bend the great power of this technology to our purposes and use it to accomplish our rationally chosen ends, assuming, of course, that we will be able to find and identify them.

We should, therefore, not look on it as a threat to our freedom and integrity as men, as Jacques Ellul does in "The Technological Society," but as a potent implement, which, if transcended and bent to our purposes, will make us almost more than men. And if, as Mr. Kahn said, "there is no intrinsic limit to computers and they will in time transcend men," we will still benefit, because, if they do transcend most men, or any one man, they will be a composite model of the ideal man—the very embodiment of the idea of or "ideas man." Imagine what we might learn from this.

And if this new technology is misused by some men to invade the privacy of others, we must and can restrain such use through law; perhaps this should be an addition to our Bill of Rights which guarantees the right of privacy to all.

Neither the complexity of our new world or the quantity of the available data must be allowed to awe and overwhelm us. We must, undismayed, attack, reduce to order and manage such material through our techniques, so as to convert it into knowledge, which can be used to serve our consciously chosen ends.

And as a nation, searching for our goals and purposes, we need the guidance of men informed by this knowledge—broadly educated men—if we are going to succeed in meeting and solving our present and future problems. Please note that I said knowledge, not information, for knowledge of a part has a way of expanding into knowledge of the whole, an overall understanding, or, at least, some vision of it which reaches across disciplines and which will be indispensable in ordering our priorities and identifyng our goals.

Also, a comparable knowledge, but in a smaller compass, a knowledge of a whole given system, is necessary if we are to make correct models; that is, models that mirror or reflect the real world and thus

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guide us to correct modes of behavior and possible courses of action.

The restoration and preservation of our physical environment, much emphasized here and elsewhere, is only one of the fundamental problems we face. For if we restore our environment and succeed in stabilizing our population at some acceptable level, we still have to decide what kind of lives we should lead as men; that is, what should the quality of our lives be, and what should the State or Nation do to support and help us accomplish these ends.

But to bring our State to accept the purposes we believe are proper to it, we must have the political process informed and guided by the knowledge or wisdom of these broadly educated and understanding men. At the least, our best educated men, not necessarily our educational leaders, must interact with, help inform and, in general, engage in a more or less continuous dialectic with our political leaders, in those cases where the two are not the same.

Thus a group such as this panel must interact with and inform a group of political leaders, such as this committee, so that they will be able to examine alternatives even when they are in different disciplines and decide upon a coherent, rational policy for our State (here I echo Mr. Bundy).

It has also been suggested by Dr. Boorstin and others that we have fulfilled certain of the former ideals or purposes of our State and that we must discover our new priorities and ends, first for ourselves as individuals and then for our Nation.

If we look to our original public purposes, the basic purposes of our State, which our Founding Fathers adumbrated as the preservation of each man's natural right to life, liberty, and the pursuit of happiness, we see that besides protecting our lives and our basic liberties (purposes which we cannot fairly say have yet been entirely liquidated), we can recognize the great and unique benefits that the postindustrial age, with its codification of knowledge, power of action and flow of services can open up for us: the basic structural and social changes that this age will bring, should be looked upon as an opportunity and not a problem.

We should now be able to make the material supports of a normal, natural life—food, shelter, clothing, medical care, et cetera, available to everyone and, thus, for almost the first time in history, enable them to pursue, through their own efforts, their further individual ends, their particular versions of happiness which lie beyond our States' concern—at least as its purposes have been hitherto stated.

If we have, as Dr. Boorstin suggests, preserved the power of seeking out and setting new and higher goals for our Nation, we now have the material and technical supports, never before available to a people, for doing so.

In attempting to discover and define the new and emerging values or purposes of our society and our State, perhaps we should learn more about our own past, as we have been here advised, so that we can draw more substance and guidance from it. Let us examine this past briefly.

Something less than 200 years ago, our Founding Fathers faced with the choice of living under what they considered to be an intolerable despotism or fighting the most powerful empire on earth, set forth in the Declaration of Independence their resolve to fight for the right to govern themselves. They thought of themselves as having the responsibility for vindicating this right, not just for their Nation or generation, but for all mankind.

The perils we face and the responsibility we bear today, as the leader of the West, are relatively no greater than those they faced and bore, but our material strength, at least—leaving aside our wisdom and virtue—is far greater than theirs, in fact, greater than any the world has ever seen. With such strength, what are our true responsibilities and what is our proper national purpose, the ends toward which our State must strive.

We must, perforce, take all necessary military and diplomatic measures physically to survive, for the protection of its citizens is the basic purpose of any State, the sine qua non of all further purposes. But great power must be used with great restraint.

Our very material wealth and military strength can be a great and immediate danger to us when used with less than wise restraint. And, in a larger but clearly foreseeable prospective, this strength can slowly corrode our security and prosperity when it leads us to act without concern for the justice of the whole, which includes, according to our own precepts, the right of all men to have the opportunity of becoming, as far as they are able, complete men.

Thus we must never forget that men are always more important than property and do what we can to make sure that everyone, everywhere is given the opportunity of acquiring the material supports of a decent, not marginal life.

In summary, we must use increments of our growing wealth wisely and prudently for public and immaterial ends, like science and education and the public amenities, things of the mind as well as the body, civilizing things which mark the true quality of a culture. As we do these things, we will be fulfilling in large part the present ends of our State, which were set by our present political philosophy. It will not, of course, be easy. But, if our sense of justice fails to sustain us in these endeavors, our instinct of self-preservation should carry us through, since all these things are necessary to the very survival of our present way of life.

Then if our vision has not grown too dim with these labors, we might set new goals for our State, guided by a higher purpose an enlightened by nobler political philosophy.

The moral nature, or character, of man would again be explicitly within the state's concern. Laws would be sought which would educate or train as well as restrain the citizens. While retaining and enlarging our true freedom, we would concern ourselves more with its proper use. Right action and understanding would replace property and power as the goals of our personal lives; while public virtue would displace popular success as the criterion of our representatives, who would thus become statesmen, rather than mere governors. As a nation, our natural, unspoilt countryside, our beautiful and useful cities, our liberating and enlightening colleges, and our wise laws, in short, all the public amenities necessary to a true polity, would, with our finest creation, our citizens, make us a civilizing force in the world. We would become a force for the proper control of arms, and thus for peace and orderly government in the nations and in the world, a force for using all the vast technical knowledge we now possess to bring natural plenty to all and, finally, a force to help men everywhere become as fully human as their natures permit. Then, when we are well into these tasks, if we were asked what the United States of America is good for, we could answer with Odysseus, the wisest of our early ancestors: "It is a good place to grow men."

Dr. BELL. Thank you very much, Dr. Poe.

I would like to give as much time to the panel for comments as possible, since this is a meeting primarily with the Panel of Science and Technology, and we have here quite a few guests, from some other countries and other agencies. I would like to give some time for comments from the audience, if there are any, as well. So very quickly, to the panel itself to see if there are any comments or questions.

Dr. REVELLE. The basic viewpoint underlying most of our discussion seems to me to have been that the purpose and function of education however it is conducted is the transmission of technical skills which people will need to fill jobs in the possible industrial society. I think this represents a fundamental misconception of the nature of the new world into which we are entering.

In the new society, education will be only in part a means to other ends. To a very large extent it will be an end in itself. It seems to me that anyone who has made contact with present-day studies or who has much contact with present-day studies will reach this conclusion. A great many of them are no longer interested in getting rich or in contributing to economic growth, let alone to advancing a technology which uses more and more ingenuity and a higher and higher level of scientific and engineering knowledge, to produce objects which are less and less useful and are often only destructive.

Most of today's studies couldn't care less about the great technical problems which renews the executive branch and the Congress of the United States, the supersonic aircraft for making a manned landing on Mars. They are interested in something quite different. They are interested in learning how to love and how to live, how to make real contact with other human beings, how to use their minds and bodies more intensely, how to be morally responsible, truly honest and fulfilled human beings.

They are asking the great questions people have always asked: Why are we here? What if anything is the purpose of human life, what does it mean to be human? This suggestion to me that when we talk about educational ideals perhaps we are not really—shouldn't think about a self-liquidating ideal but rather a return to an older one, a reestablishment of the educational ideals of the 18th century, which in turn sprang from the Greeks, the idea that education is the realm of civilized discourse, and that the educated man is the man who is a full man, not necessarily one who is technically qualified to fit into a peg in society.

The Academy of Socrates and Plato, for example, didn't represent a training for work. It was a way of life. Now, clearly this educational ideal will not fit everybody. Equality of educational opportunities clearly means a diversity of educational opportunity. We can't, we shouldn't and we really can't fit all our young people into the straitjacket of a single system. And here I think one of the most important suggestions was made by Professor Green, that education is something that must continue throughout life, as a means of heightening, deepening, and widening human experience.

Many people seem to think, and many of the students seem to think of our universities and colleges today as prisons, resthomes or daycare centers, for postadolescents. What they should be instead it seems to me is an environment in which action and fulfillment are possible for many persons, but not for all people. Particularly for those people who like to explore, to discover, and to create.

We spoke yesterday of the fact that our higher educational system is cruelly putting too great a strain on many students, because it's demanding a higher and higher level of performance which is beyond the capability and talents of many young people. This may very well be the case. But in the long run, the remedy may be something that was not suggested and that is to raise the level of intelligence of people.

There is a good deal of evidence that few of us ever use more than a fraction of our inherited brainpower. Most people aren't born stupid. They become stupid because we don't know how to give them the nurture, the environment, the stimuli, perhaps the biochemical substances they need to develop their minds.

Of all the areas of neglected research, the most neglected is the research in how people think, how they learn, how they can fulfill their mental potential. Yet there are many promising leads. For example, those coming out of the new science of linguistics. It is a truism that we are living in a type of great transition. But I suggest that we haven't yet realized what a great transition it is. We are literally sitting on the hinge of history and swinging wildly.

The real transition that is coming, and we can dimly see it, is not in our environment but in ourselves. We are becoming a new form of matter, as truly different from other living things as life is from inanimate things. This new form of matter has one unique quality, that of understanding. It has the potential of understanding, not only the world, but also itself. We may never reach the stars, but we have the great advantage over the stars that we can understand them. And it is even more fundamental, even more remarkable, that something represents an overwhelming challenge to all of us, and particularly to educators, to learn not only how to understand the stars, but how to understand ourselves; and this, it seems to me, is the challenge for education and for science that we are facing in the post-industrial society.

Dr. BELL. Thank you, Dr. Revelle. Dr. Russell?

Dr. RUSSELL. During this meeting, I have heard many references to an information explosion. There certainly is in many fields, but I am more interested with the publications explosion. The universities supposedly foster this by an alleged publish or perish policy, but our course, an imporatnt factor is the appearance of all sorts of black boxes, new gadgets, such as electronic or scanning microscopes, and this of course leads to it.

But there's another important factor, and that is the factor of personal vanity. Seeing one's name as an author of a paper or a book is often exhilarating. When I was a dean, I helped popularize the term "administrivia". This was with reference to a common malady exhibited by deans and other university officials who fall into the trap of becoming deeply concerned. As one who has kept up with earth sciences publications, numerous journals in several languages, I have come to the conclusion that their contents display huge amounts of what I call geotrivia. The hallmarks of geotrivial research include, first, a general absence of true scholarship. The real "in" paper includes references seldom earlier than 1960, and I have noted a number that include only references to papers published within the preceding year. This, of course, simplifies library research, and one thing and another. Another hallmark of geotrivial research is the use of the mathematical symbols for statements that one might readily be ashamed to express in ordinary English words. Many of these are simply glosses, science of sudo-erudition. We find that some of the most active users of equations and symbols haven't any depth in mathematical background, perhaps they have had a course or two in statistics, but really don't understand the statistical tool. In many of these geotrivial papers, we find a comment that it was received on a certain date, say, in February, revised some months later, say, the following November; and then, a month or so after it is published, possibly in June, say in July and August, then we look in the errata part of the journal, and among the errata we will see such things as statements that the second term in equation 4 should be preceded by a minus rather than a plus sign.

There is a remedy for the geotrivial explosion. We need more stringent editorial policies. Clamping down an inconsequential and prematurely submitted manuscripts. How is that accomplished? Well, the ordinary method is judgment by parties. But are the parties competent? Do the parties recognize true scholarship? And the answer too commonly is "No", to these questions. The parties tend to be the chief offenders themselves.

Now, as to a remedy for this publications explosion, we certainly need tougher editorial policies, tougher administrators at institutional levels. I would like to cite a couple of examples from my own institute. We have one young man who feels a guilt complex if he doesn't get out about a paper a week. I have succeeded in talking him out of submitting most of them, with the argument that by putting the conclusions of several of these together, we would have greater impact.

Secondly, I have encouraged him to publish in journals with known tough standards, so that he will learn the hard way.

I have another member who tends to publish the same paper half a dozen times at least. The publication will be in evening journals; in popular journals. He feels cheated if he hasn't published the papers in two or three American and at least one English journal and another in Japan.

Well, the remedy here that I have tried to pursue is to broaden his research interests, to get him out of a rut that started when he acquired his Ph. D., to acquaint him with new research possibilities, and I think this is being accomplished. He is seeing that there are other problems beyond the one he worked on. Now, in various ways I have been impressed at these meetings by a rather cheerful attitude. I thought in coming up here that I was going to listen to a great deal of information about the impending doomsday for—well, it has been published for a dozen different causes, and the probability of each has been somewhat assessed. We didn't hear much of that.

Population explosion, yes. But very little else. I see some hopeful signs that the publications explosion will be self-liquidating.

As the annual volumes of journals thicken by factors from two to ten, society does go up, the resignations from society increase. I know quite a few people who have resigned simply because their professional journal or journals are occupying too much shelf space. They can far better afford to pay than they could back in the 1930's, but they resent looking over so much trivia and jargon, particularly resent the shelf space that is being used. I hope that we are able to accelerate the process of self liquidation.

Dr. **Noyes**. Mention has frequently been made during these discussions of the use of models as a way of drawing conclusions and of foretelling the future. Of course this is not a new procedure and it is used intentionally or instinctively by all scientists and even by most human beings. There are, however, limitations which always must be kept in mind.

The use of statistical mechanics by physicists and chemists is always based on models. The name of Josiah Willard Gibbs is forever associated with this field and it has had a tremendous impact in providing a useful point of view and in reaching some conclusions.

When statistical mechanics is used to attack certain problems of reaction rates, of surfaces, of hydrodynamics the models upon which these attacks are based are known to correspond to real systems. One must ask, therefore, how good the calculations and the predictions really are. The scientific literature is becoming increasingly filled with calculations which have no real physical meaning. Let us hope that these articles aid the academic advancements of worthy faculty members because there would seem to be no other valid reason for their publication.

The real difficulty with these uses of statistical mechanics are first that not enough is known to construct valid models, and second that the relative importance of many variables cannot be assessed. Thus if one obtains a result one likes one tends to consider the method valid and this may be dangerous.

In dealing with human and environmental problems, the variables are often not fully understood and the data may be lacking adequately to test the calculations. Thus while the results may have some predictive value the ultimate validity of the approach cannot frequently be assured.

Computers, therefore, are extremely useful for retrieving data and they may ensure that the absent-minded professor does not forget an important bit of information. To go further in using computers presupposes a vast amount of research in devising, revising, and testing models. Thus some of the breakthroughs so glibly forecast in our discussions may be a little further away than just around the corner.

Dr. **Bell**. Dr. Hesse.

Dr. **Hesse**. Mr. Chairman, my recollections to the last several days, I am sure, are going to be different than what we have heard so far, because I represent that part of society that is in the free enterprise industry, the commercial point of view. And I think some of these recollections ought to be spoken here, because I believe we need a broader perspective that what has been expressed so far. I will try to do this in terms of a few items that cut me especially to the bone, and give you the viewpoint from the industrial side.

First of all, on the purpose of education, we folks in industry hire a man for how well he's trained to do the job, so I have got to maintain that the primary purpose of education is to prepare a man for gainful employment. Eventually he's got to graduate and get out and go to work. So far as we are concerned, that's got to be one primary motive of education. Now, his job of being educated is not completed. On-the-job training is a very essential part, in fact, in the real world, where men work day to day for a living, and in turn help the corporation grow and make earnings and profits so it can compete with many corporations, that's very essential.

I have a few remarks on the Paul principle. Here again, I don't believe you will find that technology overcoming the man is the primary reason that these folks are overcome by the Paul principle. I have the view that the technical part of, say, an engineering department—which I think Mr. Armer was addressing primarily, not the artisans or other people who improve themselves by on-the-job training—my observations are that people who get in large engineering departments really learn from the new folks coming in, as well as the older folks that have been there for a while. If a man is ambitious, and has knowledge of where his status is, he will take the time to learn from his younger counterparts.

In fact, industry itself is concerned about this, and they will make available to these men classes outside of the job in the evenings. In fact a good number of companies, we are doing this now; we have remote TV classrooms right in the engineering department. And our folks can take the subject of their choice, by walking less than five minutes from their desks. These are closed circuit television hook-ups to about five different universities in the area.

We are concerned about that because each individual is an asset, and we want to protect that. I really find, from my associates and experiences, that those people who go by the Paul principle, generally go because of some other common problem. They have a personality clash, or they can't get along with this particular policy. Maybe there are some personal problems at home. That's usually the culprit that forces the folks out when they get up into the middle or upper management regime.

I have heard several references to the word growth; that perhaps growth for the sake of growth is not necessarily good. But let me assure you that growth for the sake of a healthy corporation, and I think for the sake of a healthy country, is essential. I don't know of any corporation that doesn't have growth as one of its primary objectives. Certainly there has got to be growth in the new product that is developed. There must be growth in sales. So growth is always there as one of the primary objectives. Certainly growth of the value of the stock is there. In fact, if a company just remains static and doesn't grow, it is falling behind, because there is a guy across the street called Mr. Competition, and he overtakes you.

I also think that the impetuous, the stigma of growth helps recreate new things, innovations within a corporation, and that also is healthy.

There are also references to perhaps wealth or a portion of wealth as no longer a proper goal. That may be, but again, in the real world I just haven't met many people that don't want some more. They are always there. We have a lot of strikes—a big one, for example, today. As you go up in the income bracket, you just don't meet many people that don't want additional wealth. So again, from this point of view, which I think is a real world point of view, we have got to respect that aspect as well as some of the farther-down-the-road wild-blue-yonder deals. Thank you, Mr. Chairman.

Dr. Bell. Dr. Whipple.

Dr. Whipple. Thank you, Mr. Chairman.

I must say that these 2 days have been the most exhilerating with new ideas and great concepts that I have enjoyed for a very, very long time. But I have been trying to put together in my own mind a bit to see what the integration of it adds up to, and what can be done. I think I will start with Mr. Armer, and his man on the FCC. This subject has not been pursued very far, and I think the new man on the FCC and the policy of the FCC can have an enormous impact on the educational system and on the education of everyone.

This subject, I think, needs to be pursued very much farther, and I particularly want to emphasize this new television program for the preschool children, the "Sesame Street." Many of you may have seen it and many may not have. It is a reasonable example of what can be done by an intentional spending of money, and developing a program directly aimed at the preschool child in a limited cultural environment. And it parallels in entirely different fashion, of course, the Headstart concept which intends to do the same thing. But it appears, from all I can see, and from what I hear, that the Sesame Street concept is just remarkably successful, and in listing the interest of the youngsters in actually learning these fundamental facts about the alphabet, about numbers, words, spelling and so forth, that are essential before one can go to more advanced studies. It does equalize or give more equal opportunity by the television which is so prevalent now, to those who live in cultural environments where education and study have been neglected. But the difficulty, I am told, that comes there again, is that when they go to primary school after Headstart, or now I think after Sesame, they suddenly find themselves back in a dull environment again, and lose interest. So that the system's approach which I think is so important, and I believe what Dr. Kozmetsky had in mind, and Professor Beer with his esoteric boxes, must involve an enormous number of factors from the Federal Government, from the control of the news media, communications media. It must involve the ideals, self-liquidating or not, that Dr. Boorstin so brilliantly presented. Or perhaps lesser ideals that Dr. Green feels may lead us farther in the long run.

But it seems an approach must also include the parents, and I was fascinated with this continuing education of people after this 12 years, or whatever number of years. One of the problems again in most Eastern schools concerns the fact that the parents need to be educated to allow their children to be given a modern education by modern means.

I have direct experience with that, in which the mother discovers that Johnny is enjoying school. Now, when she discovers this, she feels that there is something really wrong. Now, this violates all of our older puritanical traditions, that anything worth while must come hard and you must suffer to derive any good from it.

And so I think that in education there must go into the great systems analysis of education; and, of course, with regard to goals, I was very glad to hear Dr. Revelle list the modern concept of goals so clearly and beautifully, because I do think that we are coming to a period of time in which we are changing our goals.

Now, education for its own sake, I think, is a new one that may be self-liquidating eventually; but I would be willing to see it pursued for some decades, to find out where we go with that. And I don't think we do have to encourage students to go into research or to get new knowledge. I have never tried to encourage any student to go into astronomy or to become a professional research astronomer. I have always rather discouraged him mildly and then, if he insisted that that is what he wants to do, then I will help him in every way possible. But I think it is a great mistake to try to push them early, or to over encourage them. I think they must be led on, and this is a whole new concept of education, to give them a taste of all the possibilities, so that they become interested, involved, and then go along in the direction that their own bent carries them.

There is a great deal in this system analysis of the whole educational system that can go back to the home. There is no question but what the permanent structure is largely developed at the mother's knee. I think as Roger Revelle indicated, that there is a great deal that can be done there and studies that should be made. There is no doubt that what prenatal care will certainly affect the intellectual capacity of children. I don't know whether there is any possibility of prenatal education. That may be possible sometime, I don't know. But certainly prenatal care and the postnatal care in the early years are both absolutely fundamental to the permanent structure, the type of individual that you get, and the type of interest, the type of accomplishment that he can eventually pursue.

The whole problem is so complex I don't have any answers here, but I do feel, I think it was Dr. Green, expressed this concept, that some things are so important that they should be done badly—of course he means rather than not at all. And I don't think that a systems approach in education should be tried, making use of these fantastic facilities that are now provided by the great computing maps, and by the intelligence and the concepts that have gone into them.

Certainly the results will be pretty disappointing at first, but I think that people should be encouraged to go on with these studies, to see what can be done, trying to bring all these esoteric boxes together into a grand system, and making what progress we can. Thank you.

Dr. Bell. Thank you. Dr. Stever?

Dr. Stever. Mr. Chairman, as one who is charged with the unimportant parts of education—namely, keeping the campus clean and raising the money and allocating the budget, and hiring the people—I have listened with great interest to all of the great words said here, with an eye cocked to try to get a lead as to what I might do to help one educational institution run a little faster.

Unfortunately, I have gotten a road map which is fairly complex, and I could get an authoritative opinion on almost any direction I wanted to go. However, I would like to make a point. There have been several very important statements about education, but I don't think that anyone has put all of the elements of education together in his statement of what it is.

I really believe that higher education has three components to it, three major components, from the standpoint of the student. One of the components is developing the understanding, or the development of the understanding of the world and man in it; and the larger that view is developed in the student, the better that component of education has done its job.

But I would not sell short the second component, which in olden days and in professionally oriented colleges is often described as developing the capability of earning a living. I think young people today have a much better view of this component, but it is still there. It is really developing a way to contribute to life, because one can have all the understanding of the world in the world, but one fails to fulfill himself if he hasn't done something in contributing to his life.

And so I still think that that's an important thing. I don't prescribe it as preparing to enter the industrial world, or either the pre or the post or the present world, but to enter the world as itself in a positive way. I will rate both of those very highly.

The third component which, I think, has to be present in an academic institution is not understanding about mankind and man's position in the world, but in fact the development of the man, the particular study in question. And here many of our colleagues, I think, have in fact in recent years, anyway, failed in part. I think more than anything else the student rebellion on the campus—not the student rebellion, but student activities on the campus—have pointed to the failure of this part of our educational institutions; and in fact, the students themselves are taking this part into their own hands. And when they are doing that, they spill over into the other two components of education.

I really think that when we think of upgrading our educational institutions, and when we think of sending some of our professors back to school, we ought—and sending administrators back to school, and Congressmen, and everybody else—to look very carefully at this business, the development of the particular person.

You know the college age is the age at which a young person really begins to develop his standards and develops his tastes, becomes independent, because it is the first time he is really torn away from his family. It is a tremendously important part of a person's life. My personal feeling is that more of our educational system fails in this part than it does in the other two. I have looked at lots of student evaluations of teachers, and their experience with teachers, and some of these are very deep in their understanding of what education is about. And you know, in most of these evaluations, the teachers seldom fall short with respect to their knowledge in their particular field or subject. They really fall short with respect to their human relations with the students, and their interest in the student as an individual, and so on.

So I personally think, when we are developing our colleges, we have got to look much more to this than, say, to sending teachers back to get more of the depth of specialized training which already they have in great measure.

I am not denying Mr. Armer's point that people do have to keep up-to-date, but that can be done, I think, much better. I personally believe that I would rather see us develop in this country not along the lines that have been suggested, of downgrading higher education, but rather broadening the concept of education to cover these three points much better than we now do; and I personally believe that every young person is entitled to an exposure in a system which is designed to do these together and well and in a balanced way.

Dr. **Noyes.** Education frequently intruded itself into our discussions. This was inevitable because of the preponderance of academic people in our midst. Much of what was said made sense. Some did not.

Of course most of our university students are studying to fit themselves for life and this includes earning livings. That many of them have ideals and are led to question the kind of training they are receiving is also true. One must not confuse the students who come from the affluent classes with the others and the others are in the majority.

In "selling" the public on the support of science, we have heretofore tended to emphasize military usefulness, practical applications for the improvement of living standards, and health. These may be valid bases for not neglecting science and technology but they are not enough. There is a beauty to a well performed piece of scientific research. This beauty may not be appreciated by many people at present but somehow we must make an effort to reach the public. There is no widespread objection to fine art, fine music and fine literature, and yet one finds a real prejudice against fine science. For this situation the scientists have themselves partly to blame.

It was stated, I believe, both by Dr. Boorstin and by Dr. Green that professors tend to raise standards as the previous training of students improves so that the fraction who receive passing grades does not change markedly. Certainly the fraction of young people who successfully graduate in science and engineering has changed little during recent years. And yet the number of institutions which offer training for advanced degrees continues to grow faster than the number of good available graduate students.

The cost of maintaining a trained scientist in reasonable personal and professional affluence continues to use in terms of real dollars.

One of the questions facing us is, therefore: how many people should be supported to do research without any restriction as to mission or even as to competence? It is beginning to be apparent that we can not afford to support all of those who desire this kind of life.

If the above statements are correct, the graduate schools of the country must indulge in some critical self-evaluation. Is thesis training, which often tends to be narrow, desirable for even the present number of graduate students? Is not training in advanced techniques better adapted for usefulness to government and industry more valuable than training in research which often is not in fact that at all?

There are questions which somehow need to be answered because budgets for research have reached a magnitude where they compete for money for other items of very high priority. Merely for scientists to say that research always pays dividends is no longer sufficient to get the money we would like to have. We must sell research on a new basis and somehow choose carefully the people who will be permitted to do it.

Dr. **Bell.** Mr. Goland.

Mr. GOLAND. I don't know how well I can phrase what I would like to say here, but as usual in my instance, I will try. Of the papers we have had, all of them have been very interesting, I think we should look perhaps more closely at the very fine statement of Dr. Poe. Much as I try to fight the habit of thinking that lawyers have a great deal to say on important matters, I must confess that usually I find that they do. In his statement he pointed out that technology must be used for good purpose. He didn't imply a shifting sand of changing values, ideals, goals, objectives, except as they naturally emerge toward a higher plan.

I trust that I am properly interpreting the thrust of Dr. Poe's remarks. He implied a constancy in the larger goals, along with change in some of the means by which we achieve them. It is interesting that he talked of goals, whereas yesterday Dr. Boorstin talked of self-liquidating ideals. It is rather a paradox, because the management of the national parks, I would more closely think of as a goal, and I would think the emergence of the human spirit is more that of an ideal.

Now, my interpretation is that these 2 days have had in them a great deal of intellectual impetus. On the one hand, the assumption that we can do things so well that we can end up with a perfectly regulated society, and on the other extreme, no matter what we can do, why do it?

Ultimately, everything is relative; ultimately we shall be disillusioned; and ultimately it will only lead us to further frustration.

We have had the point made just this morning by Dr. Revelle, that the basis for the discontent of our youth is in fact that they have become disenamored of the goals that up to now we have considered important. This common assumption that the new generation has suddenly emerged as a world-wide Alexandria—somehow the general ethic strain has changed, and that the youth of the country are suddenly endowed with a wisdom that up to now has been denied us.

I think the unrest of our youth has many, many causes, and certainly I don't intend to discuss them here. I contend that the cause is not that they have suddenly become over night much wiser. I think we must remember the problem. We somehow or other started talking about communications, and we ended up in a discussion of values in the world of fact. But I think we must remember that certainly for the immediate future, all of this talk of change and shift of basic values and perspectives is really self defeating; not something we should look at with promise, but something we should recognize that at least for the immediate future is self defeating.

We have to remember that most of the world is still poor. Most of the world still suffers from poverty, misery, and dissatisfaction. I think Dr. Revelle can give us the figures on that. I think we have to remember that the hope for the world comes not from changing our concepts of affluence, from changing our concepts of technology, but in fact is in the direction of reenforcing them.

The United States and other countries—but the United States primarily—has emerged as a great center of affluence. This affluence is essential to a better world. The concept that the job has been done is surprising in a group of this kind, because the job is a long way from done. It may well be that in this Nation we have taken some directions that were not necessarily the wisest, or perhaps at least history will show and disclose this. It may well be that this is a period of unrest and questioning that we go through, but I don't think this should be confused with a disillusionment of the very thing that has moved us through history continually forward. And I don't think it should be confused with the fact that the great hope of the world continues to be in future affluence, because most of the world is desperately unaffluent.

I think Senator Garcia really pointed out that is probably not how to deal with these intellectual sophisticated problems of values. His job is to help Mexico to more closely approach the kind of life that we have achieved in this country. Perhaps not in all of its cultural variations, but certainly in the part where technology is central, which is the production of goods, of things.

And so we were supposed to be talking about communications and management of information; and one of the things that this does, is permit us to further continue this work that we have done in this country for making people free of want, toward providing new things, toward providing things which, if used properly, can lead to a more satisfying life, and for the past couple of days this erosion, this intellectual erosion of everything that up to now we have held to be proper and correct, I find this a very disturbing, and if I may say so, a very dangerous course.

Dr. **Bell.** Dr. Zucrow.

Dr. **Zucrow.** Mr. Chairman, I will only address myself to one question. When I came here and read the agenda, I thought we were going to really talk about management of information, and it seems to me this has come back to the same topic, education, in a large measure. And as a former educator, I still have a great interest in education.

I had the sort of feeling from both the papers and the discussions, and whether this is what was my purpose or neglect, that the word "education" was equated primarily with getting information. Now, to me, if that is what was intended, then the best educated man, accordingly, would be the one who is so pumped full of information that he is like the proverbial cup, he runs over if you try to get any more into him. Undoubtedly information is important, because in order to study anything we have to get information about it. And even its management is also important. But its judgment of its value is by far more important. Even the fact that you can get it easily by doing it on computers, and you can get some of it now more accurately, and you don't have to do all that laboring work that you had to do is laudatory. But it still comes down to the judgment of the man who takes the information to make use of.

So my mind says that the ideal goal of education, to me, is not merely the accumulation of information, or even knowing how to handle it. I agree with Dr. Revelle, so I am not going to repeat everything he said; but the primary ideal of education is to waken, within the individual, the spark that encourages him to be a student throughout his or her life.

In addition the spark must be aroused that makes him alert and sensitive to human values, to his relationship to other people and their relationship to him.

I will not quarrel with Mr. Armer that there is no such thing as the Paul Principle, but I have to admit in my own experience and with the people I associate with, it makes me very doubtful that this is a general principle. I look back at my own education. I went to what was supposed to be a pretty good school, Harvard University, and I looked at what I studied when I graduated, and I look at the things I get into all my life, which are very different from what I was pumped full of at Harvard. But if you are not a student all your life, of course, you won't do this. But I think the object of education is to make one a student all his life; and I find this is true of most of my associates, and I hope it is true of most of my friends and my students.

The one who is truly educated in his field, to my mind, is one who is alert to changes in technology, and is able to learn and even master those changes. Undoubtedly some can do that without additional formal education, and I have not made any studies to find out whether this is many or few or everyone. I don't know. But it might be true that for many or few, or whatever that happens to be, additional formal education may be essential, as suggested by Dr. Green.

And if this is really essential, which would be based upon information which has been properly analyzed, then we should have a public policy in that regard, to take care of those people. To me, perhaps, to make things very simple, I summarize the objectives of education in this way: Should they answer the questions which start with what, how, and why? Those three questions. When they are posed, not only to your vocation—you don't live by your vocation alone—but to those things which affect the person as an individual, and also the relationship to the persons with whom he interrelates. If you can answer those questions, or know how to go about answering these questions, or know how to go about studying to answer those questions, he will come up with an answer, and he will be, to my mind, pretty close to being an educated man.

I was really charmed with Dr. Boorstin's paper. The only thing is, this may be a question of semantics. What he called ideals seemed to me goals and objectives. And I am sure, and I am an engineer, I know we would have a goal or an objective to do something, and when we completed it, we forget it, and go to something else.

I don't think that is true of what I call ideals, because ideals were things that were stated so eloquently by Mr. Poe, that I forgot to write them down while I was listening to my good friend, Harry Poe. And they, I think, are much more to achieve and, therefore, I think they are much less self-liquidating. That is all. Thank you.

Dr. BELL. Dr. Wiio.

Dr. WIIO. Mr. Chairman, I was very intrigued by the interesting paper by Mr. Armer, and I do think that his Paul Principle is a valid principle, and yesterday I started to do some computing with my portable biological computer about this new principle.

To do some computing I had to quantify the concept in the principle, and so I devised a unit of measurement which measures the rate of becoming incompetent in one's job, and as we have watts, we have volts, we have ohms, so I called this new unit of measurement "Paul"; but then I thought he might not like that, so I just called it "P."

And after further analysis of this principle, with the new unit of measurement, I found out that the unit can reach negative values instead of positive values. That means that you may become more competent in your job.

Dr. Zucrow. Then you get fired.

Dr. Who. If you take five parameters and draw a matrix, for example, of the parameters and the unit of measurement, P, and, for example the other parameter is the rate of change of knowledge about your job, and the other parameter is P. If you have no change of knowledge about your job, then the correlation of the value of P is positive—sorry, negative. You become more competent in your job, because the more knowledge you get—the more experience you get in your job, the older you get in your job, the more you know about that job, and there is no new knowledge about that job, then you become more compentent in your job.

This is very valid in some jobs, like, say, bricklaying or manual skills. If you are an old bricklayer, for example, I may be wrong, but if you are an old bricklayer, you know almost everything there is to know about bricklaying. And the value of P is minus one, if that's the limit. Then, when there is more change of knowledge about your job, you first reach zero—that is, with new knowledge you get in your job experience, you compensate for the new knowledge about the job. Then you are at zero level. Nothing happens. And then, later on, there is more and more change of your knowledge about your job, and you lag behind, and then you reach positive values of P; and when you reach the value of plus one, which is the limit, then you are fired.

I think this is a very valid behavioral model, and as we heard from Mr. Kahn, the change in computer science is very rapid. I think it was 3.2 years for one generation, or something like that, of computers. There you really lag behind. And you reach very rapidly P plus one.

Now, this leads me to the idea of Dr. Green, of having a continuous education of our people, of our citizens, until they are 14 years, or any number of years. I think that is a very good principle, and worthwhile considering, just as he proposed it, that you can sort of take it in any time of your life. It could be in the form of a social security or educational insurance, if you like it better here in America. Just as you become sick, you get pay from your insurance; if you reach the value of the P plus one, you get paid from the insurnace, and you get money to go into college or anywhere, to get retraining.

I think this is a very good idea of Dr. Green, and I am not kidding.

Mr. Knox. Dr. Bell, I wanted to comment to some extent about communication and information technology as it relates to the favorite subject in the last 2½ days, which is education. And I want to preface my remarks by pointing out that I have found it more difficult to communicate about communication, in general and somewhat abstract terms, than any other subject I have ever attempted.

There is one opportunity that the new technology offers us, that is so far beyond our present attitudes and the patterns of anything that I think it escapes us, and this is the opportunity to use these new technologies to operate in completely different ways of handling information than we have ever handled information before. And let me now say what this difference is. It is the ability to have personal control over the information system. The people in the audience have no control over what they are going to hear from the speakers, including me. I am sure they would like to have some control over what they hear.

The student in the classroom has very little control over what he hears from the teacher. It may be of interest to him that day, but something else might have been far more interesting to him that day, and it would have been far better for his learning if he learned what he was interested in that day.

Most of us in business are also not in control to the extent we would like, of the information system. We recall having seen something before. We would wish we had measured something, or the people in the organization had some data on a new product or market, but we weren't in control of that information. We would wish to be.

What I am saying is that the new technologies, based on computers, communications, microimagery, microfilm, do offer us for the first time in man's history an ability to interact in more or less conversational mode, with the store of recorded knowledge. It is not going to be easy to achieve that relationship. Most of us still feel most comfortable dealing personally with a friend when we want to communicate. But the experiments that have been made with the new technologies show that we can relate to these, let's say, a CRT tube, with a keyboard tied into a computer; they can operate very easily with that kind of device. They are familiar with it, they are accustomed to it.

After all, they spend more time in front of a television set by the time they go to school, than they have spent in school for the first five grades. They are very familiar with this technology. Most of the people in this room are very unfamiliar with the technology, and we find it very difficult to even think about it. And it seems to me that this concept must be spread more widely, because, unless people believe that such a thing is possible, they will not try to achieve it.

A few people believe that it is possible to use this magnificent new set of technologies, to put people in control of their information, from their very early childhood on, to make it possible for them to not spend so much time in the formal educational system, because it is so easy for them to gain the skills, the information, the professional expertise, relating to the system, at their timing and on their terms.

Now, the adults, of course, do have, even today, the opportunity to take a lot of adult educational courses. It is a big business in America. It is no new thing. You find that continuing education is important. There are millions of people involved in it all the time. But to make it more flexible and more responsive to people is what the new technology offers. And I would just like to restate this concept by saying that, by comparing it perhaps to the transportation problem, communication and transportation are in some ways interrelated.

People have wanted to move from one place to another for various reasons. They have developed technologies to do the moving, and the more they move, as someone pointed out earlier, the more space they take up in the moving.

People want to communicate, and they want to communicate more intensively and extensively all the time. There seems to be no limit to the people's desire to communicate. The more they communicate the more communication space they take up, too.

There is a finite limit in the human brain to the amount of communication receptivity that it has. There is also a finite limit to the rate of frequency spectrum we use for communications. There is a finite limit to the amount of recorded information we turn out.

As we communicate more and more, we develop technologies which lap over these limits of space which allow us to interact without using up the space that we would have used using the old technologies. And I feel that the placing at an individual's disposal of access to all of the information systems that we now have and can be developed, is a way of lapping over some of these space limitations on communications that we have been faced with so far. Thank you.

Dr. **Bell.** As you all know, Cronus is the real ruler of our lives, and we really now come to the end of the period, except by a few closing remarks by the chairman of the Subcommittee of the House and the chairman of the House Committees. As a moderator, I have been asked to summarize in a few quick sentences what has been said over the last two days. Normally, a moderator is supposed to sum up a blend of wisdom and exhortation, and I shan't be able to match the eloquence of Dr. Revelle, and I shan't try. I try to think of a single text, which is the occasion, perhaps, for summary, and I am struck with the formulation of Professor Beer.

Perhaps the wording itself doesn't exactly catch it, but the idea, as he puts it, that information changes us and data doesn't. And in trying to catch a sense of summary I am reminded of an old parable of the Rabbi Hillel, some of you know by now I am partial to parables as way of learning.

It is a way of condensing knowledge in a very quick form. But there is a very famous set of Rabbies Hillel and Shamai, who lived at the time of Jesus. And a very impatient man came to Rabbi Shamai and said, "Tell me all there is in Judaism while standing on one foot." And Rabbi Shamai kicked him in the leg, and the man limped away; and he came to Rabbi Hillel, and the said "tell me all there is in Judaism while standing on one foot." And Rabbi Hillel said to him, "do not do unto others as you would not have them do unto you. All the rest is exegesis. Go learn."

So in the spirit of Rabbi Hillel, if I can give a Hillel summary of the session of the last 2½ days, I would say observe the principle of Peter and Paul, but don't let data overload you. Thank you.

Mr. **Daddario.** When Dr. Bell started off these hearings in the capacity as moderator, he said, as some of you will recall, that if you don't know where you are going, any road will take you there. I think that in a sense the purpose of these hearings is so that we might better find the road, and better know where we are going; and so that we can properly set our objectives.

The meeting here has been a stimulating one. It has been obvious from the attention paid by the people who have come over this 2½-day period, that it has been extremely worthwhile. Obviously the subject matter has in itself been extremely worthwhile. From it, as has happened in the past, will certainly come recommendations which this committee will then be able work on.

The path which we must follow is not clearly discernible, as a result of these hearings, but what it does do is give us an indication. Dr. Kozmetsky said that the problem here is that we should come to some determination about what we should do, and perhaps what we should do is not what we think at the moment is what must be done. Perhaps, there are other things which are more important than pollution, crime or some of the other subjects that are constantly before us. He gave us plenty of room to move around in, because he said to make these determinations, we should begin in this century.

I would hope that this committee in its deliberations about these matters would be able to beat this time scale and be able to make some determination about how we, as a congressional committee, must make an assessment about the consequences of this technology and the society of which we are all a part. As Roger Revelle said we as a people are becoming a new form of matter. How must that be worked into what should be done? I'd like to close by saying that this is an extremely difficult proposition.

We on the committee argue a great deal among ourselves. I do regret, Mr. Armer, that we don't have some scientists on the committee. We did have one once, and he was not reelected, unfortunately. I could look to the time when we had a committee completely composed of computer scientists. I would hate to see what the results of that would be, because in the final analysis, we must put this in such terms so that it can be understood by the public and by those of us who have political responsibilities so that we can accomplish our proper objectives.

I do, Dr. Bell, want to personally think you for a most outstanding performance. We on the committee are in your debt, for not only having been an outstanding moderator, but for having added time after time contributions of your own, which have certainly cemented and molded together myriads of thoughts which have been put forth during this particular session. I will now turn the meeting over to the chairman of the full committee, Mr. George Miller of California.

Chairman Miller. Mr. Fulton, as the ranking minority member, do you have a few words to say?

Mr. Fulton. I believe the meeting has been very productive. One of the good things about it has been the disparate difficulties in approach. Where we have tried to reach a result that was agreed upon, there really have been no agreements. There has been no course laid out. It has been more like shooting rockets off into various directions. We will have to look the record over later and see how the meetings can be coordinated and organized for legislative purposes.

One good thing has been that when we are all thinking alike, nobody is thinking very much. We have a wide variety of backgrounds here and the differences in approach, have included everything from systematic to information organization, to even Dr. Zucrow's very far out and individual word, "judgment." I almost asked him to define it. I wonder what kind of judgment a professor or scholar would use as distinguished from the judgment of a Congressman.

We get to a point in Congress where we must interrelate these various fields. We must get an interface with reality. Let me tell you, in a district such as Pittsburgh, when we add up votes, either for or against the President, the energy of the force mounts up exponentially and geometrically, and not just linearly. You fellows that are here are the cutting edges. We do appreciate your being here. You have raised our sights, I believe, above the rows of corn we are hoeing every day. Thank you very much.

Chairman Miller. Thank you, Mr. Fulton.

Gentlemen, I want to sincerely thank you for your presence here and for the great contribution you have made to this committee and to the guest panelists. It has been your first experience, but as I look down at the table in front of you, there are old friends who for many years have come each year to help guide us.

Before closing I want to join in both what Mr. Daddario and Mr. Fulton said in thanking the panel members, guest panelists and Dr. Bell. All of you have made major contributions to our deliberations. I want to also acknowledge the fact that this panel is put together under the direction of Mr. Daddario, the chairman of the Subcommittee on Science Research and Development. I owe him a great debt of thanks.

Also, I would like to thank the very fine staff that we have on the committee, who support us and work with us, and I particularly want to recognize the technical work done by Colonel Gould, Colonel Wells, Mr. Hines, Mr. Dickinson, and Mr. Nichols and the fine administrative support rendered by Messrs. Giroux and Quigley and Mrs. Dodson. Without their help we wouldn't have gotten very far.

Now I have a very pleasant duty to perform. The committee, in recognition of the great services performed by the guest panelists, formally passed a resolution, and I'd like to present each of you with a copy of this resolution.

Dr. Bell. Thank you very much.

Chairman Miller. Dr. Stancescu, Dr. Poe. It is almost hard to call Harvey "doctor," I know him so well. Dr. Wiio, Dr. Green, Dr. Boorstin, Professor Beer, Mr. Armer. As one who started life as a civil engineer, I would at least recognize your title, Mr. Garcia-Roel, and I am very happy to present this to you. Again I thank you.

We are closing within 3 minutes of the time the House must convene for another session. Again my sincere thanks and appreciation for what you have done. The meeting is adjourned.

(Whereupon, at 12 o'clock p.m., the meeting was adjourned.)

APPENDIX A

BIOGRAPHIES

ARMER, PAUL

Born: November 8, 1924. Education: A.B., Meteorology, U.C.L.A., 1946. Additional courses at U.C.L.A. in Statistics, 1948–59; and Economics, 1963. Graduate of the Executive Program of the U.C.L.A. Graduate School of Business Administration, 1960.

Professional Experience: Director, Stanford Computation Center, Stanford University, Dec. 1968—present; Associate Head, Computer Sciences Department, The RAND Corporation, Santa Monica, California, 1947–68; Dispatch Clerk, United Air Lines, 1946–47; Flight Operations Officer, European Theatre, United States Army Air Corps, Air Transport Command.

Professional Activities: President, American Federation of Information Processing Societies (AFIPS), 1968–69; Vice-President, AFIPS, 1966–68; Invited witness on Computers and Privacy, Senate Judiciary Committtee, 1968; Consultant to Presidential Commission on Technology, Automation and Economic Progress, 1965; Consultant to the Warren Commission, 1965–66; U.S. Computer delegation to USSR, 1959; Mayor's Advisory Committee on Space, City of Los Angeles, 1965–69; Council of the Association for Computing Machinery (ACM), 1959–60 and 1964–68; ACM National Lecturer, 1966–67; NSF Committee on Nonteaching Mathematical Employment, 1958–63; NIH Advisory Committee on Computers in Research, 1960–61; von Karman Lecturer, City of Los Angeles, 1967; Computer Sciences Advisory Committee, Stanford University, 1967–68; SHARE Executive Board, 1955–58 and 1960; Vice-Chairman, National Joint Computer Conference (NJCC), 1959–60; ACM Representative to NJCC, 1958–61; Los Angeles County Vote Tallying Device Evaluation Committee, 1960; U.S. Air Force Systems Command Working Group on Cybernetics, 1965–66; Founders Committee, Institute for the Future, 1966—; Chairman and/or member of numerous other committees of ACM and AFIPS; Member of ACM, IEEE, and AAAS.

Publications: "Computer Aspects of Technological Change, Automation, and Economic Progress", a report prepared for the National Commission on Technology, Automation and Economic Progress, Appendix Volume 1, *Technology and the American Economy*. The Report of the Commission, U.S. Government Printing Office, Washington, D.C. 206–754–66–Vol. 1, November 1965. Published in *Automation and Economic Progress*, Howard R. Bowen and Garth L. Mangum, Editors, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966; "Social Implications of the Computer Utility", a RAND Corporation Paper, P–3642, August 1967; published in *Computers and Communications—Toward a Computer Utility*, Prentice-Hall, Englewood Cliffs, New Jersey, April 1968; "Attitudes Toward Intelligent Machines", a RAND Corporation Paper, P–2114–2, 1962; published in *Computers and Thought*, E. A. Feigenbaum and J. Feldman, Editors, McGraw-Hill Book Company, New York, 1963. Condensed versions also published in *The Evolving Society*. Institute for Cybercultural Research Press, New York, 1966, and *Penguin Survey of Business and Industry*, Penguin Books, Inc., Baltimore, Md., 1967; "The Use of Computers", published in Analysis for Military Decision, E. S. Quade, Editor, Rand McNally and Company, Chicago, 1964; "A Million Random Digits with 100,000 Normal Deviates", published by the Free Press, Glencoe, Illinois, 1955 (co-author); "Offset Circle Probabilities", a RAND Corporation Report, R–234, 1952 (co-author); "Privacy Aspects of the Cashless and Checkless Society. Testimony Before the Senate Subcommittee on Administrative Practice and Procedure", a RAND Corporation Paper, P–3822, April 1968; "Testimony Before the Commission on Manpower, Automation and Technology", a

RAND Corporation Paper, P–3118, April 1965; resulting from testimony before the California State Commission on Manpower, Automation and Technology in December 1964; "The Systems Gap", a RAND Corporation Paper, P3641, August 1967; published in *Datamation*, Vol. 13, No. 8, page 21, August 1967; "Soviet Computer Technology", co-author, a RAND Corporation Research Memorandum, RM–2541, 1959, published in the *Communications of the ACM*, March 1960, and in the *IRE Transactions on Electronic Computers*, March 1960; PACT–I (Project for the Advancement of Coding Techniques). Edited a series of papers on PACT–I published in the *ACM Journal*, Volume 3, Number 4, October 1956; "The Location of the Maximum of a Function of Two Independent Variables When the Dependent and Independent Variables are Measured Without Error", a RAND Corporation Research Memorandum, RM–15, 1947 (with Oberbeck); "Applications of a Cathode Ray Tube Readout Device for the IBM 701 Electronic Data Processing Machine", a RAND Corporation Paper, P–509, 1954. Published in the Proceedings of the IBM Scientific Computing Seminar, May 1954; "SHARE—A Eulogy to Cooperative Effort", a RAND Corporation Paper, P–969, 1956. Published in the Proceedings of the Electronic Business Systems Conference, San Francisco, November 1956.

Beer, Stafford

Cybernetician; OR scientist; company director; university professor; President, Operational Research Society; Executive Member, United Kingdom Automation Council.

From philosophy/psychology (London University) to 9th Gurkha Rifles to wartime OR to industry. 1948—Head of OR/Production Controller, S. Fox & Co. 1956—Head of OR and Cybernetics, United Steel Companies. 1961—Managing Director SIGMA (Science in General Mgt. Ltd.), consultants; Director, Metra International. 1966—Development Director, International Publishing Corporation; Chairman, Computaprint Ltd (to '68); Director, International Data Highways (to '69). 1970—consultant in mgt. science.

Fellow, Royal Statl. Socy (Industrial Cttee 1953–59, regional chairman); Fellow, Royal Econ. Socy; Member, OR Socs. of Great Britain, America, France; Member, Royal Inst. of Philosophy, New York Academy of Sciences, Socy. for Gen. Systems Res.: Founder Member, Internat. Assoc. for Cybernetics, OR Advisory Panels for Iron and Steel (Chmn. Computer Cttee. 1956–61); for OECD, Paris, Member, British Conf. on Automation & Computation (1957–60); Northern Advisory Council, BBC (1960–61); General Advisory Council, BBC (1961–69); government cttees.

Awarded Silver Medal, Royal Swedish Academy (1958); Lanchester Prize, OR Socy. of America (1966). Author of *Cybernetics and Management* (EUP, 1959); *Decision and Control* (Wiley, 1966); *Management Science* (Aldus, 1967); *Brain of the Firm* (Pelican, in prep.) and over a hundred papers. Home: Firkins, Old Avenue, West Byfleet, Surrey, England.

Bell, Daniel

Present Position: Professor of Sociology, Harvard University. Personal Data: Born: New York City, May 10, 1919; Married, two children. Education: The City College of New York, B.S.S., 1938; Columbia University, Ph. D., 1960. Work History: Staff Writer, *The New Leader*, 1939–41. Managing Editor, *The New Leader*, 1941–44. Managing Editor, *Common Sense*, 1944–45. Instructor in Social Science, University of Chicago, 1945–48. Labor Editor, *Fortune* Magazine, 1948–58. Associate Professor of Sociology, Columbia University, 1959–62. Professor of Sociology, 1962–68. Other: Lecturer in Sociology, Columbia University, 1952–56. Director, Seminar Program, Congress for Cultural Freedom (Paris) 1956–57 (on leave from *Fortune* Magazine). Fellow, Center for Advanced Studies in Behavior Science, Stanford, California, 1958–59. Visiting Professor of Sociology, University of Chicago, 1966–67. Visiting Scholar, Russell Sage Foundation, 1969–70.

Books: History of Marxian Socialism in the United States (1952). The New American Right (editor) (1955). Work and its Discontents (1956). The End of Ideology (1960). The Radical Right (editor) (1962). The Reforming of General Education (1966). Towards the Year 2000 (editor) 1968. Confrontation (editor with Irving Kristol) (1969).

Forthcoming: The Post-Industrial Society; Brisbane's Social Destiny of Man (editor); Marxian Sociology (A Reader). Memberships: Fellow, The American Academy of Arts and Sciences. Chairman of the Commission on the Year 2000, Phi Beta Kappa, Fellow, The American Sociological Association, Council, The American Sociological Association (1968–), President's Commission on Technology, Automation, and Economic Progress (1965–66). Co-Chairman, H.E.W. Panel on Social Indicators (1967–1968), Co-Editor, *The Public Interest*, Editorial Board, Daedalus, Editorial Board, *Labor History*, Editorial Board, *The American Scholar* (1962–68).

Honors: Winner of Gold Medal, American Council on Education, for the Reforming of General Education, 1966. Visiting Scholar, Phi Beta Kappa, 1967–68, L.H.D., Grinnell College, 1967, L.L.D., Case Western Reserve University, 1968.

BENNETT, IVAN L., JR.

Born Washington, D.C. on March 4, 1922. Married Martha Rhodes, 1944; children: Susan (1947), Paul B. (1950), Katherine (1952), and Jeffrey I. (1956).

Education: Emory University, A.B., 1943; M.D., 1946. Intern (medicine), Grady Memorial Hospital, Atlanta, 1946–47; Visiting investigator in bacteriology (LTJG, USNR), U.S. Naval Medical Research Institute, Bethesda, 1947–49; Fellow in Pathology, Johns Hopkins Hospital, Baltimore, 1949–50; Assistant Resident Physician, Duke Hospital, Durham, 1950–51; Chief Resident Physician, Grady Memorial Hospital, 1951–52; Diplomate, American Board of Internal Medicine, 1954.

Licenses to Practice: Georgia, North Carolina, Connecticut, Maryland, New York.

Positions held: Assistant in Pathology, Johns Hopkins University, 1949–50; Assistant in Medicine, Emory University, 1951–52; Assistant Professor of Internal Medicine, Yale Univerity, 1952–54; Associate Professor of Medicine, Johns Hopkins University, 1954–57; Professor of Medicine Johns Hopkins University, 1957–58; Boxley Professor of Pathology and Director of the Department, Johns Hopkins University, 1958–68; Deputy Director, Office of Science and Technology, Executive Office of the President, 1966–1969; Vice-President for Health Affairs, New York University, 1969—; Director, New York University Medical Center, 1969—.

Hospital Staff Appointments: Assistant Pathologist, Johns Hopkins Hospital, 1949–50; Associate Physician, Grace-New Haven Hospital, 1952–54; Attending Physician, West Haven VA Hospital, 1953–54; Physician, Johns Hopkins Hospital, 1954–58; Consultant in Bacteriology, Johns Hopkins Hospital, 1954–58; Consultant in Medicine, Loch Raven VA Hospital, 1955–58, Clinical Center, U.S.P.H.S., Bethesda, 1955–58, Baltimore City Hospitals, 1954–58; Consultant in Pathology, Baltimore City Hospitals, 1958–66; Pathologist-in-Chief, Johns Hopkins Hospital, 1958–68.

Honorary and Professional Organizations: Phi Beta Kappa; Omicron Delta Kappa; Alpha Omega Alpha; Sigma Xi; Baltimore City Medical Society; Medical and Chirurgical Faculty of Maryland; American Medical Association; American Association for Advancement of Science; New York Academy of Sciences (Fellow, 1956); American College of Physicians (Fellow); American Association of Immunologists; American Society of Experimental Pathology; Southern Society for Clinical Investigation (President, 1963–64); American Federation for Clinical Research (President, 1957–58); American Society for Clinical Investigation; Association of American Physicians; American Clinical and Climatological Association; Johns Hopkins Medical and Surgical Association; Johns Hopkins Medical Society (President, 1963–64); Interurban Clinical Club; Maryland Society of Pathologists (Council, 1956–66); Research Pathologists of America; American Association of Pathologists and Bacteriologists; Society for Experimental Biology and Medicine; International Academy of Pathology (Council, 1964–1966); American Association of Professors of Pathology; Infectious Disease Society of America; American Public Health Association; American Society of Clinical Pathologists (Fellow); Biomedical Engineering Society; American Academy of Political and Social Science; Academy of Political Science; Hyderabad (India) Academy of Medical Sciences (Honorary Member); Tokyo Society of Internal Medicine (Honorary Member); American College of Osteopathic Internists (Honorary Fellow); The Francis Gilman Blake Award, Yale, 1954; Gordon Wilson Medal, 1958; Arun Bannerjee Medal, Calcutta University, 1963.

Other Positions and Activities: Research Contract Director, U.S. Army Chemical Corps, 1955–58; Research Contract Director, U.S. Army Medical Research and Development Command, 1961–66; Consultant, U.S. Army Biological Laboratory, 1955–58; Special Consultant to Surgeon General, U.S. Army, 1957–59; Special Consultant, Epidemiology Branch, Communicable Disease Center, U.S. P.H.S., 1957–59; Consultant, Office of the Secretary of Defense, 1959–61; Consultant to Surgeon General, U.S. Army 1959–60; 1969–70; Member, Commission on Epidemiological Survey, Armed Forces Epidemiology Board, 1956–66; 1969—; Member, Scientific Advisory Board, Armed Forces Institute of Pathology, 1961—; Chairman, Board of Scientific Councilors, National Institute of Dental Research, 1966—; Member, Special Programs Advisory Committee, National Institute of Dental Research, 1969—; Member, Committee on Pathology, National Research Council, 1960—; Member, Executive Committee, Division of Medical Sciences, National Research Council, 1964–68.

Member, Committee on Influenza Research, National Institute for Allergy and Infectious Diseases, 1959–61; Member, Program-Project Committee, National Institute for Allergy and Infectious Dseases, 1961–63; Consultant to Training Committee, National Institute for Allergy and Infectious Diseases, 1965–66; Pathology Training Committee, National Institute of General Medical Sciences, 1965–66; Chairman, Pathology Test Committee, National Board of Medical Examiners, 1965–66; Member, National Board of Medical Examiners, 1966–68; Consultant, Office of Science and Technology, Executive Office of the President, 1963–66; Consultant, Office of the Secretary of Health, Education and Welfare, 1965–66; Member, Education and World Affairs Task Force on Medicine and Public Health, 1965–66; Consultant, Office of Emergency Planning, Executive Office of the President, 1966—; Member, President's Science Advisory Committee, 1966—; Chairman, World Food Panel, President's Science Advisory Committee, 1966–67.

Panel Member: President's Science Advisory Committee; International Technical Cooperation and Assistance, 1966–68; Space Science and Technology, 1968—; Environmental Quality, 1968—; Visiting Lecturer to India, Rockefeller Foundation, 1957; Member, Medical Mission to India for U.S. Agency for International Development, 1964; Member, Medical Mission to Egypt for U.S. Department of State, 1965; Member, Visiting Committee, The Research Foundation of the Washington Hospital Center, 1967—; Member, Population Crises Committee, 1967—; Chairman, U.S. Presidential Mission to Taiwan, 1968; Member, U.S. Japan Cooperative Medical Science Committee, 1966—; U.S. Delegate to Science Policy Committee, Organization for Economic Cooperation and Development, Paris, 1966–69 [OECD]; Member, U.S. Delegation to 3rd Science Ministerial Meeting, Paris, 1968 [OECD]; Member, U.S. Delegation, UNESCO Conference on Application of Science and Technology in Asia, New Delhi, 1968; Member, U.S. Delegation, UNESCO Conference on the Biosphere, Paris 1968; Consultant to Science Directorate, Organization for Economic Cooperation and Development, Paris, 1969—[OECD]; Member, Secretary-General's Study Group on Chemical and Biological Warfare, UN, 1969; Member, Long-Range Planning Committee, Johns Hopkins University, 1965–66; Trustee, Emory University Alumni Association, 1966—.

Member, Conference Committee on Medicine in Mainland China, National Academy of Sciences, 1968—; Member, University Board of Visitors, The University of Oklahoma, 1968—; Member-at-large, Executive Planning Committee, University of Oklahoma, 1967–68; Member, Board on Medicine, National Academy of Sciences, 1967—; Member, Deans Committee of the Veterans Administration Hospital, New York, 1969—; Member, Board of Managers, American Bible Society, 1969—; Member, Board of Directors and Executive Committee, American Bureau for Medical Aid to China, Inc. 1969—; Member, Organization of University Health Center Administrators, 1869—; Member, American Association for Higher Education, 1969—; Member, Board of Trustees, Better Bellevue Association, 1969—; Chairman, Ad Hoc Panel, Chemical and Biological Warfare, President's Science, Advisory Committee, 1969; Member, Advisory Panel on Science and Technology to the Committee on Science and Astronautics, United States House of Representatives, 1969—; Chairman, Panel on Biological and Medical Science, President's Science Advisory Committee, 1969—; Chairman, Ad Hoc Advisory Committee for Review of Testing Safety at Edgewood Arsenal, Md. and Fort McClellan, Alabama, Department of the Army, 1969.

Lectureships: Alpha Omega Alpha Lectures: Medical College of Virginia—1955; University of Buffalo—1955; University of Louisville—1956; Georgetown—

1956; Emory—1957; Yale—1957; Duke—1958; Cincinnati—1958; Boston—1958; Utah—1959; University of Virginia—1959; Pittsburgh—1960; Pennsylvania—1960; North Carolina—1969; University of Florida—1962; University of Alabama—1962; University of Oklahoma—1963; Cornell University—1967; Georgetown University—1967; Johns Hopkins University—1967; University of Pittsburgh—1969; Boston City House Officers Association, 1958 and 1962; Stewart Roberts Lecture, Emory, 1956; Eastman Lecture, Rochester, 1955; Gordon Wilson Lecture, 1958; William Tyndall Lecture, Utah, 1959; R. R. Huggins Memorial Lecture, Pittsburgh, 1960; James E. Paullin Lecture, Emory, 1961; Samuel W. Johnson Memorial Lecture, Connecticut Agricultural Experiment Station, 1967; Philip Ingraham Nash Memorial Lecture, 1969.

Member, Editorial Board: Bulletin of The Johns Hopkins Hospital, 1960–66; Clinical Research, 1954–56; Journal of Biochemical and Molecular Pathology, 1964—; Annual Review of Medicine, 1965–66; Laboratory Investigation (Journal of International Academy of Pathology) 1966—.

BOORSTIN, DANIEL J.

Dr. Daniel J. Boorstin, who becomes Director of the National Museum of History and Technology of the Smithsonian Institution in October 1969, is a distinguished American historian of international stature, a prominent educator, a widely-read author, and a lawyer.

Dr. Boorstin is presently Preston and Sterling Morton Distinguished Service Professor of American History at the University of Chicago, where he has served on the faculty since 1944.

Born in Atlanta, Georgia, in 1914, Dr. Boorstin was raised in Tulsa, Oklahoma. After graduating from Harvard College (summa cum laude, 1934), he went as a Rhodes Scholar to Balliol College, Oxford, England, where he attained a double first (highest honors) in two law degrees (B.A. in jurisprudence, 1936; B.C.L., 1937). He was also enrolled as a student at the Inner Temple, London.

Called (1937) as a barrister-at-law, he is one of the few Americans qualified to plead in Her Majesty's High Courts. After a Sterling Fellowship at Yale Law School (1937–38), he received a Yale doctor's degree (1940).

From 1938–42 he taught at Harvard College and Harvard Law School. After admission to the Massachusetts Bar (1942) he practiced law in Washington. He taught at Swarthmore College (1942–44). Cambridge University awarded him its Litt.D. in 1968.

Dr. Boorstin's assignments abroad have included: (1950–51) visiting professor of American History at the University of Rome, Italy; (1953) consultant to Social Science Research Center at the University of Puerto Rico; (1957) visiting professor of American History at the University of Kyoto, Japan, and lecture tour in Korea; (1959–60) lecture tour for U.S. State Department, in Turkey, Iran, Nepal, India, and Ceylon; (1961–62) first incumbent of chair of American history at the Sorbonne (University of Paris); (1964–65) Pitt Professor of American History and Institutions, Cambridge University, England, and Fellow of Trinity College, Cambridge; (1968) lecture tour for the State Department in Indonesia, Australia, New Zealand, and Fiji

Dr. Boorstin's most extensive historical work, *The Americans*, is a sweeping and analytical view of American history and American culture. The first volume, *The Americans: The Colonial Experience* (1958) was awarded the Bancroft Prize of Columbia University for 1959. The second volume, *The Americans: The National Experience* (1965), was awarded the Parkman Prize of the Society of American Historians for 1966. He is now at work on the third and final volume, to be entitled *The Americans: The World Experience*.

His other works include: *The Image: A Guide to Pseudo-Events in America* (1964); *The Genius of American Politics* (1963); *America and the Image of Europe* (1960); *The Lost World of Thomas Jefferson* (1960); and *The Mysterious Science of the Law* (1958).

Dr. Boorstin is editor of the still-growing *Chicago History of American Civilization* series (now 30 volumes) and of *An American Primer* (1966). Formerly he was American History editor for Encyclopedia Britannica. He is also a frequent contributor to scholarly and popular publications.

For young readers he wrote the popular *Landmark History of the American People* in 1968.

In 1967 Professor Boorstin was appointed by President Lyndon B. Johnson to the American Revolution Bicentennial Commission. He played a major role last year in ceremonies opening the Smithsonian Institution's National Portrait Gallery, a museum of art and history. He is a member of the Board of Vistors of the United States Air Force Academy, and served in 1968 on the President's Industry-Government Task Force on Travel.

He is President of the American Studies Association and a member of the Colonial Society of Massachusetts, American Historical Association, Mississippi Valley Historical Association, Southern Historical Association, Phi Beta Kappa, and International House of Japan.

Married in 1941 to Ruth Carolyn Frankel, he has three sons, Mrs. Boorstin has been a close collaborator and editor for all Dr. Boorstin's works.

BROWN, HARRISON S(COTT)

Chemist, educator; born Sheridan, Wyoming, Sept. 26, 1917; son; Harrison H. and Agatha (Scott) B.; B.S. Univ. of California, 1938; Ph. D., Johns Hopkins, 1941; LL.D. (hon.), Univ. of Alberta, 1961, Sc. D. (hon.), Rutgers Univ., 1964; Sc. D. (hon.), Amherst College, 1966; Sc. D. (hon.), Cambridge Univ., 1969; married Rudd Owen, Nov. 11, 1949; 1 son, Eric Scott: Instr., chemistry, Johns Hopkins, 1941–42; asst. dir. chemistry, Clinton Labs. Oak Ridge, Tenn., 1943–46; research asso. plutonium project, Univ. of Chicago, 1942–43, asst. prof. Inst. for Nuclear Studies, 1946–48, asst. prof. 1948–51; prof. geochemistry, California Institute of Technology, 1951–1967. Prof. geochemistry and professor of science and government, 1967—. Recipient Lasker Foundation award. University of Michigan Sesquicentennial Award (1967). Member and Foreign Secretary, Nat. Acad. Scis., Am. Chem. Soc. (received award in pure chemistry, 1952); Am. Phys. Soc., Am. Geol. Soc. A.A.A.S. (annual award, 1947), Am. Astron. Soc., Am. Geophys. Union, Phi Beta Kappa, Sigma Xi. Auth: Must Destruction Be Our Destiny?, 1946; The Challenge of Man's Future, 1954; The Next Hundred Years, 1957; The Cassiopeia Affair, 1968; Editor-at-Large, Sat. Rev. Home: 623 E. California Blvd., Pasadena, Calif. Office: California Institute of Technology, Pasadena, California.

Fields: Chemistry, nuclear research, geochemistry, interrelationships between scientific growth and economic development.

BUNDY, MCGEORGE

McGeorge Bundy was born in Boston, Massachusetts, March 30, 1919, son of Harvey Hollister and Katharine Lawrence (Putnam) Bundy. He received his preparatory education at the Dexter School, Brookline, Massachusetts, and the Groton (Massachusetts) School and was graduated A.B. in 1940 from Yale University. In the following year he became a junior fellow at Harvard University.

During the Second World War he entered the U.S. Army as a private in 1942 and was advanced through the grades to the rank of Captain prior to his discharge in 1946, participating in Operation Husky, the invasion of Sicily, and Operation Overlord, the invasion of France.

Following the war he served during 1946–48 as assistant to Henry L. Stimson, who was readying the manuscript of the book, "On Active Service in Peace and War" (1948), of which Mr. Bundy was co-author.

Early in 1948 Mr. Bundy served as a consultant to the programs division of the Economic Cooperation Administration, which administered the Marshall Plan. In September, 1948, he served as research analyst for foreign policy on a committee recruited by the Republican presidential candidate, Thomas E. Dewey. He then served as a political analyst for the Council on Foreign Relations, New York City, in a study of the Marshall Plan.

In 1949 Mr. Bundy returned to Harvard University as visiting lecturer in government. He was advanced to Associate Professor in 1951 and to Professor of Government in 1954, maintaining the latter position until 1961. He also was Dean of the Faculty of Arts and Sciences at Harvard University from 1953 to 1961.

In December, 1960, he was appointed by President-elect John F. Kennedy to the post of Special Assistant to the President for National Security Affairs. In this capacity Mr. Bundy served as a staff officer on foreign and defense policy for Presidents Kennedy and Johnson until March 1, 1966 when he became president of the Ford Foundation.

Mr. Bundy is editor of "Pattern of Responsibility" (1952) and "The Strength of Government," 1968. Honorary LL.D. degrees have been conferred upon him by Brown University, Harvard University, Oberlin College, Hofstra College, the University of Notre Dame, and Brandeis University, and an honorary L.H.D. degree by Yale University. Mr. Bundy is a member of Phi Beta Kappa, the American Political Science Association, and the Council on Foreign Relations. Traveling and playing tennis are his principal avocations.

Mr. Bundy was married at Beverly Farms, Massachusetts, June 10, 1950, to Mary B. Lothrop of Boston, Massachusetts. They have four sons, Stephen, Andrew, William, and James.

Dupree, A(nderson) Hunter

Historian. Born: Hillsboro, Texas, January 29, 1921; Son: George W. Dupree, Sarah Hunter; A.B. (Summa cum Laude) Oberlin College, 1942; A.M. (1947), Ph. D. (1952) Harvard University; Married: Marguerite Louise Arnold, July 18, 1946; Children: Marguerite Wright, b. April 18, 1950; Anderson Hunter Jr., b. January 24, 1954; Assistant Professor, Texas Technological College, 1950–52; Research Fellow Gray Herbarium, Harvard U. 1952–54, 1955–56; Visiting assistant professor 1956–58, associate professor, 1958–61, professor 1961–68, University of California, Berkeley. Assistant to the Chancellor, UC, Berkeley, 1960–62. George L. Littlefield Professor of American History, Brown University, 1968—.

Consultant to Committee on Science and Public Policy; National Academy of Sciences, 1963–64; NASA History Advisory Committee; AEC History Advisory Committee; Fellow, Center for Advanced Study in the Behavioral Sciences, 1967–68; Project director on grants from National Science Foundation; U.S. Naval Reserve, 1942–46, Rank on separation, Lieutenant; Navy unit commendation; Member: American Academy of Arts and Sciences, American Historical Association. Organization of American Historians, American Association for the Advancement of Science, History of Science Society, Society for the History of Technology, American Studies Association, Phi Beta Kappa, Congregationalist.

Books: *Science in the Federal Government* (Cambridge, Mass., 1957); *Asa Gray* (Cambridge, Mass., 1959); Ed., Gray, *Darwiniana* (Cambridge, Mass., 1963); Ed., *Science and the Emergence of Modern America* (Chicago, 1963).

Home: 114 Morris Ave., Providence, R.I. 02906; Department of History, Brown University, Providence, R.I. 02912.

Garcia Roel, Fernando

Born August 14, 1921, Monterrey, N.L., Chemical Engineer—UNAM, 1943; Master of Science (IQ); University of Wisconsin, 1948. Professor of Chemical Engineering in the Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM), 1945–1959; Rector, ITESM, 1969—. Citations: Distinguished Service Diploma, School of Engineering, University of Wisconsin, Honorary Doctors Degree, University of the Americas, 1966.

Goland, Martin

Applied Mechanics; born New York, N.Y., July 12, 1919; married 1948; M.E., Cornell, 1940; LL.D. (Honoris Causa) St. Mary's University (San Antonio, Texas) 1968; Instr., eng'g mechanics, Cornell, 1940–42; head, applied mechanics section, airplane div., Curtiss-Wright Corp., 1942–46; Midwest Research Institute, 1946–55 (chmn., eng'g mechanics, 1946–50; dir. for eng'g scis., 1950–55); Southwest Research Institute, 1955—(vice pres., 1955–57; vice pres. and dir., 1957–59; pres., 1959—). Fellow, American Society of Mechanical Engineers; Fellow, American Institute of Aeronautics and Astronautics; Research Soc. of Amer.; fellow, Amer. Assn. for the Advancement of Science; member, Panel on Sci. and Tech., Com. on Science and Astronautics, U.S. House of Representatives; Chm., U.S. Army Weapons Command Advisory Group and member Army Scientific Advisory Panel, Department of the Army; member, Missile Advisory Group, Army Missile Command; President, San Antonio Symphony Society. Editorial advisor for Applied Mechanics Reviews; author of over 60 papers on structures, aerodynamics, dynamics, mathematics, engineering analysis, research administration. Council member, National Academy of Engineering; member, Research and Technology Advisory Committee on Aeronautics, National Aeronautics and Space Administration. Member, Undersea Warfare Advisory Board, Dept. of the Navy; Scientific Advisory Committee, Harry Diamond Laboratories; Scientific Advisory Committee, Bell Aerosystems Co. Address: Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas 78228.

Fields: applied mechanics, applied mathematics and engineering analysis. Diversified experience in structures, aerodynamics and fluid flow, aircraft dynamics, operations research, and research administration.

Member, Board of Directors, Engineers Joint Council; Member, U.S. National Commission for United Nations Education, Scientific and Cultural Organization; Member, Board of Directors, National Bank of Commerce, San Antonio, Texas; Member, Materials Advisory Board, National Research Council.

Green, Thomas F.

Home: 624 Cumberland Avenue, Syracuse, N.Y. 13210; 472–9916. Office: 1206 Harrison Street, Syracuse, N.Y. 13210; 477–8439.

Formal Education and Degrees: 1944–1948, University of Nebraska, B.A., Philosophy & Government; 1948–1949, University of Nebraska, M.A., Philosophy; 1949–1952, Cornell University, Ph.D., Philosophy.

Professional Experience: 1967, Director, Educational Policy Research Center, Syracuse University Research Corp., Syracuse, N.Y.; 1966, Professor of Education, Syracuse University; 1964–1966, Associate Professor of Education, Syracuse University; 1959–1964, Associate Professor of Education, Michigan State University; 1958–1959, Assistant Professor of Education, Michigan State University; 1955–1958, Assistant Professor of Humanities, Michigan State University; 1952–1955, Instructor, English and Social Science, School of Mines and Technology, Rapid City, South Dakota.

Related Activities: 1968, John Simon Guggenheim Fellowship and Alfred North Whitehead Fellowship for period September 1969 to September 1970; Proposed Studies: Education and the Transmission of Moral Ideals; 1966, J. Richard Street Lecturer, Syracuse University. Topic: *Education and Pluralism: Ideal and Reality.* Provost Lecturer: Michigan State University. Topic: *The Modern Meaning of Classical Views of Work and Leisure;* 1965, Robert Jones Lecturer in Education: Mid-winter series of four lectures at Austin Theological Seminary, Austin, Texas. Topic: *Work, Leisure, and the Structure of Hope;* 1965, Guest Lecturer in Education at the Up-state Medical Center, program in social psychiatry. This series has been continued every year. Lecturer and Seminar Leader; Danforth Annual National Workshop on Liberal Education. Lecture Topic; *The Paradoxes of Liberal Education.* Seminar Topic: *Urbanization as an Educational Process.* Guest Lecturer: The General Assembly of the United Presbyterian Church in the U.S.A. Topic: *The Americanization of Conflict: Some Cultural Assumptions;* 1964, Provost Lecturer: Michigan State University. Topic: *Teaching, A Model of the Political Process;* 1963, Visiting Professor of Philosophy, Colorado College, Colorado Springs, Colorado (summer); 1962–1963, (Sabbatical Year) Senior Research Fellow: Princeton Theological Seminary; 1960, United States delegate to World Conference on Teaching and Theology, University of Strasbourg; 1959, Associate Member, East-West Philosopher's Conference, University of Hawaii (summer).

Professional Associations: American Philosophical Association, American Society for Public Administration, Philosophy of Education Society.

Writings and Publications: A. *In Print:*

1969, "Post-Secondary Education: 1970–1990," *Dilemmas of American policy,* Syracuse University Publications in Continuing Education, November 1969; 1968, *Work Leisure and the American Schools* (Random House, 1968). Book-length study of the ideology of work and its role in the philosophy of education; 1966, *Education and Pluralism: Ideal and Reality,* J. Richard Street Lecture at Syracuse University (Syracuse University Press); 1965, "More on the Topology of Teaching," *Studies in Philosophy and Continuing Education* (A reply to the critics), Vol. IV, No. 3.

1965, "Teaching, Acting, and Behaving," A Discussion, *Harvard Educational Review*, Vol. 35, No. 2, "Authority and the Office of the Teacher," "Education and the Theory of Man," "The Nature of Wonder" and appearing in *Essays in Education and Theology*, edited by Marjorie Reeves, published by World Student Christian Federation, Geneva; 1964, "Teaching, Acting, and Behaving," *Harvard Educational Review*, Vol. 34, No. 4, p. 507–524.

Reprinted in: Psychological Concepts of Education, ed. Paul Komisar and C. J. B. Macmillian (Rand-McNally, 1967). *Problems and Issues in Contemporary Education:* A collection of the best from the *Harvard Educational Review and Teacher's College Record* (Scott-Foresman, 1966). *Philosophy and Education*, ed. Israel Scheffler (Allyn and Bacon, 1966), "A Topology of the Teaching Concept," *Studies in Philosophy and Education* (Vol. III, No. 4, pp. 284–320).

1963, "The Importance of Fairy Tales," *The Educational Forum*, November 1963, pp. 95–102, 1958, "A Humanities Teacher Looks at Engineering Education," *Journal of Engineering Education* (volume and number unknown to me).

B. *In Process:* "Schools and Communities: A Look Forward," to appear in the Spring 1969 issue of the *Harvard Educational Review;* "The Net Result: Certification or Citizenship," to appear in *Anthropological Views on Education* (approximate title) edited by Stanley Diamond (Free Press); *The Activity of Teaching: On Introduction to Conceptual Analysis*, a set of original studies in the philosophy of education. The set as a whole constitutes a coherent philosophy of pedagogy. Each essay is also accompanied by a discussion of the methods of thinking displayed in the study. The aim is to provide the student with an example of analysis together with some guidance in how to do it himself. (McGraw-Hill) Projected publication date: winter 1969–70.

School Reform and the Urban Public: Some Alternatives, a monograph on the relation between educational policy, the profession and the lay public together with some proposals for alternative steps to effect school reform. Senior author, Professor Gerald Reagan. Based on observations in Harlem, Boston, Chicago, Los Angeles, and Philadelphia. Expected completion: summer 1969; *Letters to Larry*, a set of fifteen to twenty informal and personal explorations of theological and biblical topics. The question is "How might a relatively corrupt, deeply secular man rationally assess the claims of the Christian and Hebrew traditions upon his life?" No projected completion date. A labor of love in the most literal sense.

HESSE, WALTER J(OHN)

Aeronautical-mechanical engineer; born St. Louis, Mo., April 4, 1923; son, Christian and Viola (Kammeier); B.S.M.E., Purdue, 1944, fellow, 1946–49; M.S.M.E., 1949; Ph. D., 1951 Pi Tan Sigma, Tau Beta Pi, Sigma Xi; married Bettie Sanford, 1947; children: Jenna, Jean, John Walter, Janice Lynn, Kristine Ann, Stacey Lee; U.S.N., 1943–46, Lt.; Rocket Motor Research fellow and instr., Purdue, 1946–49; and chief engr., test pilot training div., Naval Air Test Center, Md., 1949–56; supervisor of theoretical propulsion, 1956, chief of advanced development planning, 1956–59, manager of advanced systems engineering, 1959–61, Chance Vought Aircraft Corp.; program dir., nucleonic systems, 1961–64, program dir., advanced missile systems, 1964, Vice President, program dir., V/STOL, 1955—, Vice President, Development Programs 1968–1969, Vice President, Plans and Requirements, Vought Aeronautics Corporation—Ling-Temco-Vought, Inc., Visiting prof., Maryland Univ., 1949–56; lectr., Southern Methodist, 1956–57, Consult., adv. panel aeronaut. U.S. Dept. of Defense. Member: adv. bd., Joint Task Force Two, Joint Chiefs of Staff; Panel on Science and Tec., Com. on Science and Astronautics, U.S. House of Representatives; Astronautics Soc.; Amer. Nucl. Soc.; Ord. Assn.; Amer. Inst. of Aeronautics and Astronautics; Texas Comm. Atom. Energy, Dallas; Atom. Engr. Adv. Comm., Southwest Interest; bd. dir., Ft. Worth Council of Scientific Societies; Purdue Univ. Distinguished Alumnus Award Apr. 1966. Author: Textbook "Jet Propulsion," 1958, and "Jet Propulsion for Aerospace Applications" (with Mumford), 1964. Various papers on propulsion, nucleonic systems missiles and aircraft. Home: 4847 Allencrest Lane, Dallas, Texas.

Fields: Propulsion, V/STOL aircraft, nuclear power systems for missiles, weapons systems analysis.

KAHN, HERMAN

Herman Kahn, a physicist and specialist in public policy analyses, is Director and Trustee of Hudson Institute and was one of its principal founders. As Director he is the senior officer and has principal responsibility for the over-all research program. Among his major interests at Hudson Institute have been studies on Latin American and other development problems, inquiries into alternative world futures and long-run (10 to 35 years) political, economic, technological and cultural changes, and research into strategic warfare and basic national security policies.

Before he left to help found Hudson Institute in 1961, Mr. Kahn was associated for twelve years with The RAND Corporation. There he worked on problems in applied physics and mathematics, operations research and systems analysis, weapon design, particle and radiation diffusion, civil defense, and strategic warfare. During 1959 he was on leave for six months as a Visiting Research Associate at the Princeton Center for International Studies while working on the manuscript of his book, *On Thermonuclear War.*

Mr. Kahn is the author of six books: *On Thermonuclear War* (Princeton University Press, New Jersey, (1960); *Thinking About Unthinkable* (Horizon Press, New York, 1962); *On Escalation: Metaphors and Scenarios* (Frederick A. Praeger, New York, 1965); in collaboration with Anthony J. Wiener, *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years* (The Macmillan Company, New York, 1967) prepared for the Commission on the Year 2000 of the American Academy of Arts and Sciences; and with members of the Institute Staff, *Can We Win in Vietnam?* (Praeger, New York, 1968) and *Why ABM? Policy Issues in the Missile Defense Controversy* (New York, Pergamon Press, 1969). He has written articles for such publications as *New York Times Magazine, Fortune, Saturday Evening Post, Bulletin of the Atomic Scientists, Daedalus* and *Commentary*, and has also contributed articles to several books on defense and foreign policies. Among his publications while at The RAND Corporation are articles on such subjects as gamma ray absorption, Monte Carlo methods, systems analysis techniques, war gaming, and game theory, in addition to his writings on strategic warfare. He has lectured at the Army, Air, Industrial and National War Colleges, the University of Chicago, Yale, Berkeley, Harvard, Princeton, Columbia, London School of Economics, the California and Massachusetts Institutes of Technology, and other universities and at defense study centers in France, Germany, Holland, Israel, Norway, and Sweden.

Mr. Kahn has served as a consultant to The Gaither Committee on Civil Defense and Strategic Warfare, the U.S.A.F. Scientific Advisory Board, the Atomic Energy Commission, Oak Ridge National Laboratory, the Office of Emergency Planning, the Office of the Secretary of Defense, the Army, Navy and Air Force, and to numerous industrial and scientific concerns.

Born in 1922, Mr. Kahn holds a B.A. degree in physics and mathematics from the University of California at Los Angeles (1945) and a M.S. degree in physics from California Institute of Technology (1948). He is a member of the Council on Foreign Relations (New York), the Center for Inter-American Relations, the American Political Science Association, Phi Beta Kappa, and Phi Mu Epsilon.

KOZMETSKY, GEORGE

Dr. George Kozmetsky became dean of The University of Texas College of Business Administration and Graduate School of Business in September, 1966.

He came to UT Austin following a six-year association with Teledyne, Inc., a California-based electronics firm of which he was co-founder and executive vice president.

In addition to the deanship, Dr. Kozmetsky holds the academic rank of professor in the Management Department at UT Austin and of clinical professor in the Bio-Engineering Department at the UT Medical School in San Antonio.

He also serves the UT System as executive associate for economic affairs, conceiving and developing long-range plans and studies regarding the development and management of the economic resources of the UT System.

Dr. Kozmetsky's professional specialties include system analysis, organization theory, quantitative methods, information handling, application of digital computing techniques and system management.

He has had wide experience both in academic and business fields.

He formerly taught at the University of Washington (1940–41), Harvard Graduate School of Business Administration (1947–50) and Carnegie Institute of Technology Graduate School of Industrial Administration (1950–52).

Dr. Kozmetsky entered the business world in 1952 as a senior member of the technical staff in the advanced electronic laboratory of the Hughes Aircraft Company. He joined Litton Industries in 1954, serving for five years as director of the computers and controls laboratory in the electronic equipments division and one year as vice president and assistant general manager of that division.

In 1960, he and a Litton associate founded Teledyne, Inc., in Hawthorne, Calif., an enterprise which has become a major company in the defense electronics industry.

A native of Seattle, Wash., Dr. Kozmetsky received a Bachelor of Arts degree in political science from the University of Washington (1938), and Master of Business Administration (1947) and Doctor of Commercial Science (1957) degrees from Harvard University.

He is a former president of the Institute of Management Sciences and a member of the American Statistical Association and the National Association of Accountants.

Currently, he is a consultant to the NASA management advisory panel and to the Institute for the Future. He also is on the board of directors of the Adlai Stevenson Institute for International Affairs and a number of banking and business enterprises.

Dr. Kozmetsky has served as a member of the Presidential Advisory Committee on the National Data Center and has been a consultant to the U.S. Air Force scientific adivsory board.

His published works include "Electronic Computers and Management Control" (co-author), "Centralization vs. Decentralization" (co-author) and "Financial Reports of Labor Unions."

Dr. Kozmetsky is married to the former Ronya Keosiff, and they are the parents of three children.

Malone, Thomas F(rancis)

Dr. Thomas F. Malone, Senior Vice President and Director of Research, The Travelers Insurance Company, was born in Sioux City, Iowa, 1917. He was graduated in 1940 with a degree in general engineering from the South Dakota State School of Mines and Technology. In 1962, Dr. Malone received an honorary Doctor of Engineering degree from the South Dakota State School of Mines and Technology and in 1965, he received an honorary Doctor of Humane Letters degree from St. Joseph College. Married Rosalie A. Doran, December 30, 1942; children—John Harold, Thomas Francis, Mary Ellen, James Kevill, Richard Kevin, Dennis Patrick.

Upon completion of his engineering studies, Dr. Malone began his formal training in meteorology in the Graduate School of the Massachusetts Institute of Technology, where he received the degree of Doctor of Science in meteorology in 1946. In 1941, he was appointed to the staff in the Department of Meteorology at M.I.T. and was promoted to assistant professor in 1943 and associate professor in 1951.

Between 1942 and 1945, Dr. Malone assisted in the training of groups of Air Force and Navy officers to be forecasters with the armed services. He was appointed a special consultant to the Air Weather Service in 1945 and served a tour of duty in North Africa where he gave lectures to Air Weather Service officers. In 1949, he was appointed editor to the Compendium of Meteorology, a thirteen hundred page volume devoted to an appraisal of scientific progress in meteorology.

In 1954, Dr. Malone was appointed Director of The Travelers Weather Service and the Travelers Weather Research Center for The Travelers Insurance Company. In 1956, he was named Director of Research; in 1964, was appointed Second Vice President; in 1966, he was appointed Vice President and Director of Research; and in 1968, was promoted to Senior Vice President and Director of Research.

Dr. Malone is Past President of the American Geophysical Union and Past President of the American Meteorological Society. He was elected Secretary for International Participation for the American Geophysical Union in 1964. In October 1967, he was elected a Bureau Member of the International Union of Geodesy and Geophysics. He served as Chairman of the U.S. National Commission for UNESCO during 1965–1967; he served as Chairman of the Committee on Atmospheric Sciences of the National Academy of Sciences from 1962–1968, and presently serves as Chairman of the Geophysics Research Board and Chairman of the Advisory Committee on International Organizations and Programs for the Office of the Foreign Secretary. He is a member of the Advisory Panel on Science and Technology to the Committee on Science and Astronautics of the U.S. House of Representatives. He served on the Visiting Committee, Engineering and Applied Physics at Harvard from 1963–1969 and on the Visiting Committee for the Department of Earth Sciences at the Massachusetts Institute of Technology from 1961–1968: In 1969, he was elected a Director to the Board of the Alumni Association of the Massachusetts Institute of Technology.

Dr. Malone is a member of the Connecticut Research Commission and the Connecticut State Weather Control. In 1966 he was named Connecticut Conservationist of the Year for his leadership as Chairman of the Connecticut Clean Water Task Force. He is a member of the Board of Directors of the Greater Hartford Chamber of Commerce. Dr. Malone is a member of the Board of Governors of the Insurance Institute for Highway Safety, and was a member of the Secretary's Advisory Committee on Traffic Safety of the Department of Health, Education, and Welfare. He serves on the Transportation Safety Committee of the Society of Automotive Engineers, Inc. In 1967, Dr. Malone was appointed by President Johnson to serve as Chairman of the National Motor Vehicle Safety Advisory Council. He serves on the Advisory Board to the School of Environmental and Planetary Sciences of the University of Miami; he is a member of the Committee on Applications of Science and Technology of the New England Council, a member of the Advisory Committee to the Automobile Insurance and Compensation Study of the Office of the Secretary of Transportation and a member of the Special Committee on Population Distribution of the National Planning Association.

Dr. Malone is Chairman of the Board of Directors of The Travelers Research Corporation, and serves on the Boards of St. Francis Hospital, the Children's Museum of Hartford, Conn., Dynage, Inc. and Cunningham Supply, Inc. He serves on the Board of Trustees of the University Corporation for Atmospheric Research, the Board of Trustees of the Connecticut Joint Council on Economic Education, and the Board of Associate Trustees of St. Joseph College.

In recent years, Dr. Malone's attention has been directed to problems of economics and business forecasting, and he prepares monthly economic analyses for the Greater Hartford Area. In 1962, he was awarded the Charter Oak Leadership Medal for his economic forecasts in the Greater Hartford Area. In September of 1967, Dr. Malone was appointed a member of the Science and Technology Committee of the Chamber of Commerce of the United States.

In 1960, Dr. Malone received the Losey Award from the Institute of the Aerospace Sciences, and in 1964, he was the recipient of the Charles Franklin Brooks Award from the American Meteorological Society. In January, 1968, he received the Cleveland Abbe Award for Distinguished Service to Atmospheric Sciences by an Individual from the American Meterological Society. In April, 1968, Dr. Malone was elected to membership in the National Academy of Sciences. He is a Fellow of the following societies: the New York Academy of Sciences, the American Association for the Advancement of Science, the American Geophysical Union and the American Meteorological Society. Dr. Malone is a member of the Econometric Society.

Fields: Applied meteorology, synoptic climatology, science and public policy.

NOYES, W(ILLIAM) ALBERT, JR.

Chemist and univ. prof.; born Terre Haute, Ind., April 18, 1898; son, William Albert and Flora (Collier); student Univ. Illinois, 1916–17; A.B., Grinnell (Ia.) Coll., 1919; D. Sc., 1946; D.-es-Sc., Univ. of Paris, France, 1920, also hon. doctorate, 1957; D. Sc., Univ. of Rhode Island, 1952; D. Sc., Univ. of Paris, D. Sc., Indiana Univ., 1958; D. Sc., Univ. of Ottawa, 1960; D. Sc., Univ. of Montreal, 1961; D. Sc., Univ. of Illinois, 1964; D. Sc. Carleton Univ. (Ottawa) 1964; Univ. of Rochester, 1965; student, Univ. of Geneva, Switzerland, 1920; Univ. of California, 1920–21; married Sabine Onillon, June 10, 1921; 1 son, Claude Charles. Instr., Univ. of California, 1921–22, Univ. of Chicago, 1922–23; asst. prof., Univ. of Chicago, 1923–29; assoc. prof., Brown Univ., 1929–35, prof., 1935–38; prof., Univ. of Rochester, 1938–63, chmn., chemistry dept., 1939–55, dean graduate school, 1952–56; acting dean and dean, Coll. Arts and Sciences, 1956–58; Ashbel Smith prof. chem., Univ. of Texas, 1963—; chmn., division, Chemistry and Chemical Technology, Nat. Research Council, 1947–53; chmn., com. on chem. warfare, Research and Development Bd., 1948–50; vice pres., Internat. Union of Chemistry, 1947–51; treas., Internat. Council Sci. Unions, 1952–55; exec. committee, Internat. Union Pure and Applied Chemistry, 1955–59, pres., 1959–63. Montgomery lectr., Univ. of Nebraska, 1956; Westman Memorial lectr., Chem. Inst. Can., 1955; Harkins lectr., Univ. of Chicago, 1956. Served as pvt., corpl., sergt., 2d lt., Signal Corps, U.S. Army, 1917–19; Officer, Legion of Honor, France. Sect. chmn., Nat. Defense Research Com., 1940–42; div. chmn., 1942–46. On staff of chief, Tech. Div. Chem. Warfare Service, U.S. Army, 1942–46; adviser, U.S. delegation, 1st conf., UNESCO, 1946, alt. del., 3rd conf., 1948, 7th conf., 1958; Naval Research Advisory Committee, 1947–52; member, bd. of trustees, Sloan-Kettering Inst. for Cancer Research, 1950–63. Received Kings Medal for Service in Cause of Freedom, Medal for Merit, Am. Phil. Soc.; Priestly Medal, American Chemical Society, 1954, Willard Gibbs Medal, 1957. Member, Nat. Acad. Sciences (member council, 1947–50), American Chemical Society (chmn., com. on professional training of chemists, pres. 1947), Am. Acad. Arts and Sciences, Am. Phys. Soc., N.Y. Acad. Sciences, Ill. Acad. Sciences, member, COSPAR. Hon. member, Chem. Soc. of France; Chem. Soc. of Belgium; Royal Soc. of Physics and Chem. of Spain; Acad. of Sciences of Lisbon. Sigma Alpha Epsilon, Alpha Chi Sigma, Phi Lambda Upsilon, Sigma Xi, Phi Beta Kappa, Conglist Author: Modern Alchemy (with W. A. Noyes, Sr.), 1932; Photo-chemistry of Gases (with P. A. Leighton), 1941; Traite de Chimie Physique (with H. Weiss) (translation into French of text by E. W. Washburn), 1925; Spectroscopie et les Reactions Initiees par la lumiere, 1938. Editor, Chem. Revs., Jour. Am. Chem. Soc., Jour. Phys. Chemistry. Home: 5109 Lucas Lane, Austin, Tex., 78731.

Fields: Electrochemistry, photo-chemistry, vapor pressures, reaction kinetics, fluorescence, spectroscopy.

POE, LUKE HARVEY, JR.

Professional Experience: 1966–present, Partner law firm of Howard & Poe, with a general practice in Washington, D.C.; 1963–1966, President, International Technical Assistance and Development Company (ITADCO), Washington, D.C., a division of Aerojet-General Corporation; 1961–1963, Assistant to the President (later Chairman of the Board), Aerojet-General Corporation, El Monte, California; 1960–1961, Assistant Chairman, National Citizens Committee for Kennedy and Johnson; Chairman, Citizens Committee, President's Inaugural Committee; 1953–1960, Tenure Tutor (full Professor), St. John's College, Annapolis, Maryland (Director, Physics and Chemistry Laboratory, 1959–1960); 1950–1953, Rhodes Scholar, Christ Church, Oxford University, working towards a D.Phil (Doctor of Philosophy) degree; 1946–1950, Tutor, St. John's College, Annapolis, Maryland (Assistant Dean, 1947–1949); 1942–1946, Active duty, U.S. Navy, with rank from Ensign to Lieutenant-Commander (Combat experience in Atlantic and Pacific theaters, with two personal citations, one unit citation and eight battle stars); 1941–1942, Practice of law with Cravath, Swaine & Moore, New York City.

General Activities: Chairman, Miller for Governor Committee, Virginia, 1949; Chairman, Annapolis Residents' Association, 1957–1960; Vice Chairman, Committe for Annapolis, 1959–1961.

Lecturer: International Labor Center of State Departemnt; The Political Science Association of Minnesota; Foreign Service Institute of State Department; Air War College of U.S. Air Force; Aspen Institute of Humanistic Studies; Dean's Advisory Council, Lehigh University School of Business Administration, 1962–65; Seminar on Science, Technology and Public Policy (Brookings Institution, Washington, D.C.), 1964–1966; Council on Trends and Perspective of U.S. Chamber of Commerce, 1966–present; Chairman, Annapolis Board of Zoning Appeals, 1966–present; Mayor's Task Force, Annapolis, Maryland, 1967–present; Washington Institute of Foreign Affairs, 1967–present; Consultant, National Endowment for the Arts and Humanities, 1967–present; Department of Transportation, 1968–present.

Education: McGuire's University School, Richmond, Virginia, 1924–34 (Chairman, Jack Gordon Honor Committee; Jack Gordon Memorial Medal; University of Virginia Senior Scholarship); University of Virginia: B.S. (Mathematics), 1938 (President Raven Society: Phi Beta Kappa; President, Commerce Society; Editor, Virginia Magazine; Varsity Track, three letters); LL.B., 1941 (Editor, Law Review; Phi Delta Phi; Assistant Discussion Leader, Institute of Public Affairs, 1939, 1940); Oxford University, Christ Church: D.Phil. (Political Philosophy), 1957 (Bullington, Vincents, Senior Common Room and High Table of Christ Church).

Military Service: Active duty with U.S. Navy, 1942–46: escort duty in North Atlantic (U.S.S. Symbol) and Flag Secretary to Admiral commanding Iceland Command, 1942–44; Assistant Gunnery Officer, U.S.S. Mississippi (Battleship '41) in Pacific, 1944–46; Ensign to Lt.-Cdr. DX, USNR; two personal citations, one unit citation and eight battle stars.

Publications: Various articles in the *University of Virginia Law Review; The Combat History of the Battleship U.S.S. Mississippi*, U.S. Navy Department, 1947; *The Transition from Natural Law to Natural Right.* Dissertion Manuscript, Bodleian Library, Oxford University, 1957; *Einstein's Theory of Relativity* (in collaboration), St. John's College, 1957; *Electro-Magnetic Theory*, Physics Laboratory Manual (in collaboration), St. John's College, 1959.

Professional Associations: Member of District of Columbia, Virginia and Federal Bar Associations; American Association of University Professors.

Clubs: The Society of the Cincinnati (Virginia Society); Metropolitan (Washington); City Tavern Association (Washington); National Capital Democratic (Washington); The Brook (New York); Commonwealth (Richmond, Virginia); New Providence (Annapolis, Maryland); Vincent's (Oxford, England).

Personal: Born January 29, 1916. Single. Permanent Residence: 139 Market Street, Annapolis, Maryland 21401. Telephone: (301) 263–6245. Washington Residence: 2100 Massachusetts Avenue, N.W., Washington, D.C. 20008. Telephone: (202) 293–2100. Office Address: 1701 Pennsylvania Avenue, N.W., Washington, D.C. 20006. Telephone: (202) 298–8333.

POUNDS, WILLIAM F.

Management. Education: B.S.—1950—Carnegie Institute of Technology. Major: Chemical Engineering; M.S.—(with distinction)—1959—Carnegie Institute of Technology. Major: Mathematical Economics; Ph. D.—1964—Carnegie Institute of Technology, Industrial Administration.

Academic Experience: Research Assistant—Carnegie Institute of Technology—1957–1958; Ford Foundation Fellow, Carnegie Institute of Technology, 1958–1959; Assistant Professor of Industrial Management, Massachusetts Institute of Technology, 1961–1964; Associate Professor of Management, Massachusetts Institute of Technology, 1964–1966; Professor of Management, Massachusetts Institute of Technology, 1966—Present; Dean, Sloan School of Management, Massachusetts Institute of Technology, 1966—Present.

Industrial Experience: Assistant to the General Manager of the Forbes Finishes Division, Pittsburgh Plate Glass Company, 1960–1961; Industrial Engineer, Kodak Park Works, Eastman Kodak Company, 1950–1951 and 1955–1957. Military Experience: U.S. Navy, Lieutenant J.G., Naval Aviator, 1951–1955; Honorary and Professional Societies: Omicron Delta Kappa, The Institute of Management Sciences, Tau Beta Pi.

Publications: Statistical Scheduling of a Highly Mechanized Production Facility—coauthored with E. P. Kraai, *Journal of Industrial Engineering*, 1959, Vol. 10, pp. 17–20; The Scheduling Environment, in J. F. Muth and G. L. Thompson (editors) *Industrial Scheduling*, Englewood Cliffs, New Jersey: Prentice-Hall, 1963, pp. 6–13; *A Study of the Effect of Performance on Individual Goals*, M.I.T., School of Industrial Management, Working Paper No. 06–62, 1962; *A Study of Goal Structure*, M.I.T., School of Industrial Management, Working Paper No. 19–63, 1963; *Theory and Method in the Exploration of Human Decision Behavior*—coauthored with G.P.E. Clarkson, M.I.T. School of Industrial Management, Working Paper No. 32–63, 1963; also in the *Industrial Management Review*, 1963; *A Study of Problem Solving Control*, M.I.T., School of Industrial Management, Working Paper No. 33–63, 1963; *The Process of Problem Finding*, M.I.T., Sloan School of Management, Working Paper No. 148–65, 1965.

Revelle, Roger (Randall Dougan)

Richard Saltonstall, Professor of Population Policy in the Faculty of Public Health; Director of the Harvard Center for Population Studies; Member of the Faculty of Arts and Sciences; Fellow of Adams House.

Dr. Revelle, internationally known for his investigations of the physical nature of oceans, has devoted much of his time in recent years to the problems of developing countries.

During 1961–1963, he headed a panel of experts in the natural and social sciences and engineering which studied the problems of land and water development in the great Indus River basin of West Pakistan. This "White House-Interior Panel," appointed by President Kennedy at the request of President Mohammed Ayub Khan, developed a plan for increasing agricultural productivity to sustain the region's rapidly growing population. In recognition of this work, Dr. Revelle was decorated in 1964 with the order of "Sitara-i-Imtiaz" by the President of Pakistan "for conspicuously distinguished work in science." During the same year, he was appointed by the Indian Parliament as one of five foreign members of the Education Commission of the Government of India. This Commission was charged to study and make recommendations concerning the entire Indian education system from pre-school to university. The report of the Commission was published in 1966 and is being used as a blueprint for widespread educational reform in India.

He became a member of the United States National Commission for UNESCO in 1958, and later was elected Vice Chairman of the Commission and Chairman of its Committee on Natural and Social Sciences. He was one of the U.S. representatives at the General Conferences of UNESCO in 1960 and 1964, and at the General Assemblies of the International Council of Scientific Unions in Washington in 1958, in London in 1961, in Vienna in 1963, Bombay in 1966, and Paris in 1968.

He was a member of the U.S. delegation to the first Atoms for Peace Conference in Geneva in 1955 and to the United Nations Conference on Application of Science and Technology for the Benefit of the Less Developed Countries in 1963. He was one of four international advisers to a UNESCO conference in Beirut in 1963 on organizing national scientific efforts in the countries of North Africa and the Middle East, and in 1967 he was an adviser to O.E.C.D. on scientific planning in developing countries.

He attended the "Pugwash" meeting of scientists from both sides of the Iron Curtain at Baden, Austria, in 1960, Stowe, Vermont, in 1961, London in 1962, Udaipur, India, in 1964, Venice in 1964, Addis Ababa in 1965–66, Ronneby in 1967 and Sochi, U.S.S.R., in 1969.

Dr. Revelle was instrumental in planning and organizing the oceanographic program of the International Geophysical Year (July 1, 1957–December 31, 1958), serving as an American Delegate to the first planning conference in Rome in 1954 and at others in Brussels, Barcelona, Rio de Janiero, and Tokyo. He initiated and led the organizing phase of the International Indian Ocean expedition which involved ships and scientists of many nations in 1958–63 in a comprehensive physical, biological, chemical, and geological survey of the hitherto almost unknown Indian Ocean. He was the first Chairman of the U.S. National Committee for the International Biological Program, and a member of the Special Committee for this Program appointed by the International Council of Scientific Unions.

During the 1950's he organized a series of international cooperative research projects, such as the NORPAC expedition, which involved nearly simultaneous measurements of properties of the North Pacific by 20 research vessels of Japan, Canada, and the United States, and the Scripps Institution's NAGA expedition to the South China Sea and the Gulf of Thailand in cooperation with the Thai and South Vietnamese governments.

Dr. Revelle was the United States member of the International Advisory Committee on Marine Sciences formed in 1955 by the United Nations Educational Scientific, and Cultural Organization, with representatives from nine nations. Later, he became President of the Special Committee on Oceanic Research, organized by the International Council of Scientific Unions. These two committees one inter-governmental, other representing scientists in their private capacities, worked with the American Association for the Advancement of Science to organize and conduct the first International Oceanographic Congress at the United Nations in 1959. Dr. Revelle was President of the Congress which brought together 1,500 scientists from all parts of the world. He was instrumental in founding the Intergovernmental Oceanographic Commission, now comprising 40 member states of the United Nations. He was Chairman of the United States Delegation to the Commission in 1962, and was President of the International Association of Physical Oceanography from 1963 to 1967. He was appointed Deputy Foreign Secretary of the Academy in 1967.

A joint United States-Japan Committee on Scientific Cooperation was organized in 1961 at the request of President Kennedy and Premier Ikeda. Dr. Revelle was appointed by the Secretary of State as Chairman of this Committee's Panel on Scientific Studies of the Pacific Basin.

Within the United States, Dr. Revelle has been a member of several Panels of the President's Science Advisory Committee, the two most recent being the Panel on Pollution which published its report, "Restoring the Quality of Our Environment" in 1965, and the Panel on World Population and Food Supplies which published the three-volume report "The World Food Problem" in 1967. He is also a member of the Research Advisory Committee of the Agency for International Development, the Scientific Advisory Panel of the House Committee on Science and Astronautics, and the Naval Research Advisory Committee. He was elected to the National Academy of Sciences in 1957, and to a four-year term as a member of the Council of the Academy from 1962–1965. From 1963 to 1966 he was Chairman of the Academy's Section of Geophysics. He is currently Chairman of the Science Organization Development Board of the National Academy (now called the Board on Science and Technology in Development) which works with national scientific organizations in the less developed countries. He was formerly a member of the Academy's Committee on Oceanography and is now a member of the Joint Environmental Studies Board of the National Academy of Sciences—National Academy of Engineering. The Academy gave him its Agassiz Medal in 1963 for "outstanding achievement in oceanography." He was cited for "significant contributions to the understanding of oceanic processes and the geology of the sea floor, and for the stimulus he has given, through his research and special efforts, to the advance of scientific oceanography throughout the world."

Dr. Revelle was born March 7, 1909, in Seattle, Washington, received the A.B. degree from Pomona College in 1929, attended Claremont College in 1929–30, and received the Ph.D. degree in 1936 from the University of California. He was Teaching Assistant at Pomona College in 1929–30, held a similar position at the University of California the following year, and joined the Scripps Institution of Oceanography as a Research Assistant in 1931. He attained the rank of Professor of Oceanography in 1948, and was Director of the Institution from 1951 to 1964. From 1958 to 1961 he was Director of the La Jolla campus of the University of California and Dean of the School of Science and Engineering at La Jolla. During 1961–1963, he took leave to occupy the newly created post of Science Advisor to the Secretary of the Interior. He returned to the University of California in 1963 as University Dean of Research for all campuses of the University, resigning this position in 1964 to accept his present appointment at Harvard. Revelle College, the first of the new colleges established in the University of California, San Diego, was named in his honor by the regents of the University in 1965.

During World War II, Dr. Revelle served as a Commander in the United States Navy. During 1946–47, he headed the Geophysics Branch of the Office of Naval Research, and organized the oceanographic investigations for Operation Crossroads, the 1946 Atomic Bomb test at Bikini Lagoon, where he and his associates measured the waves produced by the explosives, the diffusion of radioactive waters, and their effects on marine organisms. While serving as Science Adviser to the Secretary of the Interior, was a member of the Federal Council for Science and Technology and Chairman of its Committees on Natural Resources, Water Resources Research, and the Use of Nuclear Power for Sea Water Conversion.

Among Dr. Revelle's research achievements is the development, with Sir Edward Bullard and Dr. Arthur Maxwell, of methods to measure the flow of heat from the earth's interior out through the floor of the ocean. This work in the early 1950's, during the oceanographic expeditions which Dr. Revelle led to the Central and South Pacific, opened new paths to fundamental understanding of the origin of the earth and the geological history of the ocean basin. The measurements by Dr. Revelle and his colleagues provide strong supporting evidence that the earth began as a cool rather than a hot body, and that the heat that now escapes through land surfaces and oceans results from natural radioactivity in the solid rock mantle beneath the crust of the earth. It is believed that, over geological intervals, this heat flow has been responsible for the movements of the mantle that determine the shapes and movements of continents and continually renew the ocean basins, producing the central ocean ridges and the deep trenches observed on the ocean floor.

Dr. Revelle's early oceanographic research involved the analysis of deep sea cores, the measurements of bottom currents and studies of the physical and chemical processes in sea water. More recently he studied the exchange of carbon dioxide between the ocean and the atmosphere, a major contributing factor, along with the consumption of fossil fuel on earth, to the "greenhouse" through which the atmosphere traps and stores heat from the sun.

Dr. Revelle is vice-president of the American Academy of Arts and Sciences, and a member of the American Philosophical Society, The Council on Foreign Relations, and of many professional organizations. He is an author of more than 100 scientific articles in professional publications. He holds the Albatross Medal of the Swedish Royal Society of Science and Letters, honorary Doctor of Science degrees from Pomona College, Carleton College, Bucknell University, and the University of Massachusetts, and the Doctorate of Humane Letters from Williams College. In 1963 he was appointed by President Kennedy to the President's Committee on the National Medal of Science and was reappointed for a four year term from 1965 to 1968 by President Johnson. He was awarded the Bowie Medal of the American Geophysical Union in 1968, the highest honor bestowed by that organization for "unselfish cooperation in Research."

Dr. Revelle is married to the former Ellen Virginia Clark of Pasadena, California. They have four children and ten grandchildren.

ADDENDUM

Ten grandchildren; Vice-President, American Academy of Arts and Sciences, 1968——; U.S. Delegate to General Assembly of the International Council of Scientific Unions, Paris, 1968; Attended Pugwash meeting in Ronneby, Sweden, 1967; Ceased being Chairman of the U.S. National Committee for the International Biological Program in 1968; Finished term as President of the International Association for Physical Oceanography in 1967; Finished term as Member of NAS Committee on Oceanography in 1968; Received Bowie Medal of American Geophysical Union in 1968.

Honorary degrees from: Williams College, L.H.D., 1967, Bucknell University, Sc.D., 1968, University of Massachusetts, D.S.c., 1968, Dartmouth College, Sc.D., 1968; Appointed Deputy Foreign Secretary, NAS, 1967.

RUSSELL, RICHARD J(OEL)

Physical geographer and univ. prof.; born Hayward, Calif., Nov. 16, 1895; son. Frederick James and Nellie Potter (Morrill); A.B., Univ. of California, 1919, Ph. D., 1926; married Dorothy King, 1924 (died 1936); 1 son, Benjamin James; married 2d Josephine Burke, 1940; 4 sons, Robert Burke, Charles Douglas, John Walter, Thomas William. Teaching fellow, Univ. of California, 1920–22, asso. in geography, 1923–25; asso. prof. geol., Texas Tech. Coll., 1926–27; asso. prof. of geography, Louisiana State Univ., 1928–29, prof. phys. geog. since 1930, head dept. 1936–49; asst. dir., Sch. of Geology, 1944–49, dean grad. sch. 1949–62; Boyd prof. of geography, 1962; Univ. California, Hitchcock Prof., 1966; geologist, Louisiana Geol. Survey, 1935–40; dir., Coastal Studies Inst. of Louisiana State Univ., 1953 to 1966. Ensign U.S.N.R.F., 1918–19. Received first W. W. Atwood award for studies in phys. geog. from Assn. Am Geographers, 1937. Internat. Assn. of Sedimentologists (Council, 1952–60) Member, U.S. Mil. Establishment Research and Development Bd., Com. Geophys. and Geog., 1948–54 (since 1954 General Sciences panel). Fellow, A.A.A.S. (v.p., chmn., Sec. E., 1961), Am. Geog. Soc., Geol. Soc. of Am. (pres. 1957) Chmn. S.E. Section, 1969; member, Assn. Am. Geog. (pres., 1948); Distinguished Service Award and Life Membership, 1961; Nat. Research Council (representative 1941–44; member, exec. com.; Div. Geo. and Geog. 1942–44, vice chmn., div. of geol. and geog., 1942–54, chmn., 1954–55) Am. Assn. Petroleum Geologists (distinguished lectr., 1943), Am. Geo. physical Union, Soc. Belge Geol. Paleo, et Hydrologie, 1948; Royal Geography Society of Netherlands (hon); Phi Sigma Kappa, Theta Tau (nat. pres., 1928–32); Gamma Alpha, Phi Sigma, Phi Kappa Phi, Sigma Xi (nat. lectr., 1959), Vega gold medal, Royal Swedish Society of Anthropology and Geography, 1961, Cullum Geographical Medal of the Am. Geog. Soc., 1963; U.S. Navy, Distinguished Public Service Medal, 1967; pres., Council of Deans of Southern Graduate Schools, 1953, cor.

member, Acad. of Sciences, Gottingen (Germany), member, cor. Royal Danish Acad. of Sciences, Nat. Acad. of Sciences, Democrat. Mason. Clubs: Faculty (Louisiana State Univ. (pres., 1946)); Cosmos (Washington). Asso. editor, Geologie der Meere and Binnengewasser (Berlin), 1939–41, Zeitschrift fur Geomorphologie, since 1957, Monograph Series, Assn. Am. Geographers, 1957–61; Geo. Science News, 1967—. Contrib. numerous articles to sci jours. Home: 4575 Highland Rd., Baton Rouge, Louisiana, 70808.

Fields: Geomorphology and Structure of Great Basin, climatic map of California, dry climates of the United States, climatic years, cheniers, deltas of the Mississippi River, stream patterns, geomorphology, climatology, coastal geomorphology.

SPILHAUS, ATHELSTAN

Meteorologist and oceanographer: b. Cape Town, Union of S. Africa, Nov. 25, 1911; s. Karl Antonio and Nellie (Muir); came to U.S. 1931, naturalized, 1946; B. Sc., U. Cape Town, 1931, S.M., Mass Inst. Tech., 1933, D. Sc., U. Cape Town, 1948; hon. Sc. D., Coe Coll., 1961; hon. D. Sc., U. of Rhode Island, 1968; hon. D. Sc., Hahnemann Medical Coll., 1968; hon. D. Sc., Phila. Coll. of Pharmacy & Sci., 1969; Research asst., M.I.T., 1933–35; asst. dir. of Technical Services, Union of South Africa Defense Forces, 1935–36; res. asst. in Oceanography, Woods Hole Oceanographic Inst., 1936–37, investigator in physical oceanography, 1938–60, assoc., 1960, honorary staff mem. 1969; asst. prof., New York U., 1937, assoc. prof., 1939, prof., 1942–48, chairman, dept. meteorology, 1938–47, dir. res., 1946–48; dean, Inst. Tech., U. Minnesota; 1949–66; pres., Franklin Inst., Oct. 1967–69; Pres. American Association for the Advancement of Science, 1970; Served U.S. Army Air Force, 1943–46; meteorological advisor, U.S. Africa Govt., 1947; sci. dir. weapons effects of two Nevada atomic tests, 1951; consultant, Armed Forces Sp. Weapons Project, DOD, 1951; mem., Baker Mission to Korea, Jul. 1952; mem. and chairman, U.S. Army Signal Corps Res. and Dev. Ad. Council, 1950–59; U.S. rep., Exec Bd., UNESCO, 1954–58; U.S. commissioner, Seattle World's Fair, 1961–63; mem., Pacific Sci. Bd., NAS–NRC, U.S. Nat. Commission for IGY, cttee, on polar res., cttee. on natural resources: ch. cttee on pollution, cttee. on oceanography, 1961–64; Nat. Sci. Bd., 1966–72. Chairman, Sci. Ad. Cttee., Am. Newspaper Publishers Assoc., Nat. Fisheries Center and Aquarian Advisory Bd., Dept. Interior: Sci. Advisory Cttee., WHOI; Met. Soc.; dir., Marine Tech. Soc.; fellow Royal Am. Inst. Aero. Astro.; bd. dir. Amer. Assoc. Ad. Sci., 1963–67, mem. U.S.N.C. Tech Panel Earth Satellites, IGY; ad hoc panel on oceanography, Office Sci. Tech.; Comite Mondial, U. Usine, Paris; Royal Soc. S. Africa; Amer. Geophysical Union; Amer. Met. Soc.; Amer. Soc. Limnology and Oceanography; Sigma Xi, Tau Beta, American Philosophical Soc., Cosmos Club; bd. trustees, Sci. Service, Inc.; Inst. Oceanographic Found., Am. Museum of Electricity; Pacific Sci. Center Found.; Museum Cttee., St. Paul Inst.; Aerospace Corp. L.A., bd. dirs., Am. Museum Archaeology: Nat. Oceanography Assoc.; Advisory bd., Nova U.; exec. cttee. Task Force on Resources Recreation and Conservation Commission on 1976, Am. Acad. Arts Sci.; consultant, G.E. (1952–54), General Mills, 1950–58, Honeywell, Inc., 1950–64. Awarded Legion of Merit, 1946; Civilian Service Medal, U.S.A.F., 1952; Patriotic Civilian Service Award, Dept. Army, Proctor Prize of R.E.S.A., 1969, Invented bathythermograph, Spilhaus space clock. Author: Workbook of Meteorology, 1942; Weathercraft, 1951; Meteorological Instruments, 1953; Satellite of the Sun, 1958; Turn to the Sea, 1959; The Ocean Laboratory, 1966; more than 100 articles in scientific journals and several articles on Experimental Cities.

STANCESCU, IOAN, D.

Prof. *Ioan D. Stancescu* is ordinary Professor at the Technical University of Bucharest and Counsellor in the National Council of Scientific Research, Bucharest, Romania.

He was born in 1911 in Ploesti, Romania, where he attended the High School. In 1936 he graduated from Berlin Technical University with a degree in Electrical Engineering (E.E.). For eminent study results he was granted the rare award Siemens Ring Foundation Prize.

1. Professional Career

After three years work as a project engineer in the Thermal Power Plants Division of the Siemens-Schuckert-Works in Berlin, where he was involved with the newest development of high live steam conditions, he returned home and became soon the head of the new created Natural Gas Network Division of the Gas and Electricity Company of Bucharest, introducing natural gas distribution under the most advanced conditions in Europe.

Between 1948 and 1968 he contributed directly as Chief Engineer of the Institute for Power Studies and Projects and as technical Director of the Electrification Division in the Ministry for Electrical Power to the modern lay-out and development of the Romanian Power System and to solve the main managerial problems of the subsequently created new organizations.

Since 1968 he is a Counsellor in the National Council of Scientific Research.

2. Teaching Career

In 1948 Prof. Stancescu entered as an associate Lecturer the Technical University of Bucharest, became in 1957 an associate Professor and in 1968, as a full time job, an ordinary Professor, Head of the Chair for Management Problems and a member of the University Senate.

He lectures on Management Problems, respectively on Energy Economy and Combined Production of Heat and Power.

He gives lectures in Post-graduate Courses as well and directs Ph. D. dissertations (i.e. Cybernetic Models of macro and micro economic Systems).

3. Other Activities

Prof. Stancescu is a member or an officer of several scientific and technical Councils acting in the field of Energy or Management. He belongs to the Board of the Ministry for Electric Power, to the Board of the Committee for Atomic Energy and to the Scientific Council of the Center of economic Computation and economic Cybernetics in Bucharest.

He is since 1953 the Chief Editor of the Romanian monthly periodical "Energetica" and a member of Scientific Reductional Committee of the periodical "Mitteilungen der VGB" in the Federal Republic of Germany.

4. Final Remarks

Prof. Stancescu contributed to many technical and economic studies and published 75 papers and books in Romanian or other languages (see Annex).

He gave many lectures on technical or management subjects, in Romania, radio and television included, as well as abroad (Austria, Belgium, Federal Republic of Germany, Hungary, Poland and U.S.A.) and participated often in international meetings.

He speaks fluently English, French and German.

References in the U.S.A.:

Mr. Walker L. Cisler, Chairman of the International Executive Council of the World Energy Conference, Chairman of the Board, The Detroit Edison Company, Detroit.

The Ford Foundation, New York, Mr. Stanley T. Gordon.

PUBLISHED PAPERS AND BOOKS

	In Rumania	In other countries
Books	2	1
Papers	48	11
Papers presented in international conferences	2	11
Total	52	23
Total	75	

Selected Titles

1. Public Supply of Heat. Tecnhica si Viata. nr. 5 (1940) pag. 21–27.
2. Actual Trends in the Construction of big Steam Power Plants. Bul. Min. El. Energy, nr. 10 (1950) p. 15–22.
3. World Energy Survey I and II, Energetica Nr. 1 (1956) p. 5–12 and nr. 2, p. 60–69.

4. The Economic Aspect of Power as a Factor in the Development of Underdeveloped Countries. Scientific World, nr. 1 (1958) p. 25–29.

5. Energy in long range Planning, Energetica, nr. 7 (1958), p. 293.

6. Technical and Economic Bases of Combined Heat and Power Supply. First edition (1961), second (1967). Editura Technica, 1967. 471 p. The first edition was translated in Hungary, the translation of the second will be printed next year in the Federal Republic of Germany.

7. The economic training of future Engineers. Revue of the Ministry of Education, nr. 5 (1964), p. 29–33.

8. Combined Supply of Heat and Power in Romania. Brennstoff-Wärme-Kraft (Federal Republic of Germany), nr. 7 (1965) p. 323–29.

9. World Experience in the Management and Organisation of Industrial Enterprises, IDT 1966 and 1967, 400 p. (with other authors).

10. Optimizing an 110–400 kV Electric Lines Programme, Economic Computation and Economic Cybernetics. Studies and Research. nr. 4 (1967), p. 23–38 (with other authors).

11. Energy Impact of Industry Concentration. UNO–ECE EP/44. Opening lecture of the UNO-Symposium on the Problem of Electricity and Heat Supply for large Industrial Complexes, Bucharest 1968.

STEVER, H(ORTON) GUYFORD

Educator; born Corning, N.Y., Oct. 24, 1916; son Ralph Raymond and Alma (Mott); A.B., Colgate Univ., 1938, Sc. D. (hon.), 1958; Ph. D., California Inst. Tech., 1941 LL.D., Lafayette College, 1966; LL.D., University of Pittsburgh, 1966; Sc. D., Northwestern Univer-1967; LL.D., Allegheny College, 1968, D.H., Seton Hill College, 1968; D.Eng., Washington and Jefferson College, 1969; married Louise Risley Floyd, June 29, 1946; children—Horton Guyford, Sarah Newell, Margarette Risley, Roy Risley. Staff member, radiation lab., Mass. Inst. Tech. and instr., officers radar sch., 1941–42, asst. prof., aero, eng'g, 1951–56, prof. aeronautics and astronautics, 1956–65, asso. dean, eng'g, 1956–59, head mechanical eng'g dept. and head, naval architecture and marine eng'g dept., 1961–65; pres., Carnegie-Mellon University, Feb. 1965—; exec. officer, guided missile program, 1946–48; chief scientist, USAF, 1955–56; consultant, aero. industry. Member, bd. dir., Fisher Scientific Co., Pittsburgh, Pa., and Koppers Co., Pittsburgh, Pa.; United Aircraft Corporation, East Hartford, Conn.; System Development Corporation, Santa Monica, Calif.; member, secretariat, guided missiles com., Joint Chiefs of Staff (1945; sci. liaison officer, London Mission, ORSD, 1942–45; member: guided missiles tech., evaluation group, Research and Development Bd., 1946–48; sci. adv. bd. to chief of staff, USAF, 1947–69, vice chmn. 1956–61 chmn., 1962–69; steering com. of tech. adv. panel on ordnance to Asst. Sec. of Defense, 1954–56; steering com. tech. adv. panel on aero., Dept. of Defense, 1956–60; Defense Sci. Bd. 1956–69; adv. panel, Com. on Science and Aeronautics, U.S. House of Representatives; chmn., spl. com. space tech., NASA; chmn., research adv. com. missile and spacecraft aerodynamics, Nat. Aeronautical and Space Authority, 1959—; member: Air Force Systems Command Bd. Visitors: member, National Academy of Engineering and past Chairman, Aeronautics and Space Engineering Board; adv. council, Dept. Aero. Eng'g, Princeton Univ.; Member, President's Commission on the Patent System, 1965–66; Member, Special Commission on the Social Sciences, National Science Foundation, 1967–69: Recipient, President's Certificate of Merit, 1948; Exceptional Civilian Service award, USAF, 1956; Scott Gold medal from Am. Ordnance Assn., 1960 DOD Distinguished Public Service Medal, 1969; Fellow, Amer. Inst. Aeronautics and Astronautics (formerly Inst. Aero. Scis.) (vice pres., 1958–59, pres. 1961), Am. Acad. Arts and Scis., A.A.A.S., Am. Phys. Soc, Royal Aeronautical Soc; member: Phi Beta Kappa, Sigma Xi, Sigma Gamma Tau, Tau Beta Pi, Pi Tau Sigma, Am. Soc. Mechan. Engrs., Am. Soc. for Eng'g Education. Trustee, Colgate Univ., Sarah Mellon Scaife Foundation, Aerospace Education Fndn. of Air Force Assn. Club: Cosmos (Washington), Duquesne Club, Rolling Rock Club, Pittsburgh Golf Club, Century Club, New York City (Pittsburgh). Episcopalian. Contrib. profl. publs. Home: 1045 Devon Road, Pittsburgh, Pa., 15213. Office: The President's Office, Carnegie-Mellon University, Pittsburgh, Pennsylvania, 15213.

Fields: Gas discharge geiger counters, cosmic rays, radar guided missiles, hypersonic dynamics, shocktubes, transonic aircraft, nuclear propulsion for aircraft, condensation in high speed flow.

VAN ALLEN, JAMES A(LFRED)

Physicist and educator; born Mt. Pleasant, Iowa, Sept. 7, 1914; son, Alfred Morris and Alma (Olney); married Abigail Fithian Halsey II, Oct. 13, 1945; children—Cynthia, Margo, Sarah, Thomas, Peter: B.S., (summa cum laude) Iowa Wesleyan Coll., 1935: M.S., Univ. Iowa, 1936, Ph. D., 1939; Hon. Sc. D., Iowa Wesleyan College 1951; Grinnell Coll., 1957; Coe Coll., 1958, Cornell Coll., 1959, Univ. of Dubuque, 1960, Univ. of Michigan, 1961, Northwestern Univ., 1961, Illinois Coll., 1963, Butler Univ., 1966, Boston College, 1966, Southampton College, 1967, Augustana College, 1969. Research fellow, physicist, dept. terrestrial magnetism, Carnegie Inst. of Washington, D.C., 1939–42; physicist, dept. terrestrial magnestism, Carnegie Inst. of Washington, D.C., 1939–42; physicist, group and unit supervisor, applied physics lab., Johns Hopkins, 1942, 1946–50; organizer, leader, sci. expdns., study cosmic radiation, Peru, 1949, Gulf of Alaska, 1950, Greenland, 1952–57, Antarctic, 1957; prof., physics, head, Dept. Physics and Astronomy, Univ. Iowa, 1951—; research fellow, Guggenheim Memorial Foundation, 1951 at Brookhaven Nat. Lab.; research asso., Princeton, 1953–54. Development radio proximity fuze, Nat. Defense Research Council, OSRD; pioneer, high altitude research with rockets, satellites and space probes. Served as Lt. Cdr., U.S. Navy, 1942–46 ordnance and gunnery specialist, combat observer. Received C. N. Hickman medal for development Aerobee rocket, Amer. Rocket Soc., 1949; physics award, Wash. Acad. Sci., 1949; space flight award, Amer. Astronomical Soc., 1958; distinguished Civilian Service Medal, U.S. Army, 1959; Louis W. Hill space transp. award, 1959; first Iowa award in sci., 1961, first annual research award, Amer. Rocket Soc., 1961; Elliott Cresson medal, Franklin Inst., 1961; space flight award, Internat. Acad. of Astronautics, 1961; John A. Fleming award Amer. Geophysical Union, 1963, 1964; Golden Omega award, Elec. Insulation Conf., 1963; Commander of Order du Merite pour la Rechehche et l'Invention, Paris, France, 1964. Fellow, Amer. Physical Soc.; Amer. Geophysical Union; Inst. Radio Engrs.; Amer. Rocket Soc., Amer. Astronautical Soc.; American Academy of Arts and Sciences Member, Iowa Acad. Sci.; Nat. Acad. Scis. (member, space sci. bd.), Internat. Acad. Astronautics (founding member); Sigma Xi; Gamma Alpha; Cosmos Club; Royal Astronomical Soc. (U.K.); Amer. Philosophical Soc.; Rocket and Satellite Research Panel (Chmn., 1947–58, member, exec. com. 1958–), 1946—: Technical Panel on Earth Satellite Program (IGY), 1955–58; chairman, working gp., Internal Instrumentation, 1956–58; Subcmte. on Upper Atmosphere, Nat. Advisory Cmte. on Aeronautics, 1948–52; Technical Panel on Rocketry (IGY), 1955–58; Technical Panel on Cosmic Rays (IGY), 1956–58; Technical Panel on Aurora and Airglow (IGY), 1957–58; Adv. Com. on Nuclear Physics, Office Naval Research, 1957–60; Space Sci. Bd., Nat. Acad. Sci., 1959–; Adv. Com. on Physics, Nat. Sci. Fndn., 1957–60; Panel on Sci. and Tech., Com. on Science and Astronautics, U.S. House of Representatives, 1961—; Editorial Bd., Space Science Reviews, 1962—. Consultant, President's Sci. Adv. Com.; Particles and Fields Sumcmte., Nat. Aeronautics and Space Adm., 1961—; Pres., Planetary Sci. Section, Amer. Geophysical Union, 1964–68; Chmn., Iowa's Internat. Cooper. Year Cmte. on Sci. and Tech., 1965; Ad Hoc Sci. Advisory Cmte., NASA, 1966; Chmn., Ad Hoc Panel on Small Planetary Probes, Space Sci. Bd., Nat. Acad. Sci., 1966; Member, Lunar and Planetary Missions Board, NASA, 1967—, Contbg. author: Physics and Medicine of the Upper Atmosphere, 1952; Rocket Exploration of the Upper Atmosphere. Editor: Scientific Uses of Earth Satellites, 1956; asso. editor, Jour. Geophysical Research, 1959–68, Physics of Fluids, 1959—. Published over 160 scientific papers. Home: 5 Woodland Mounts Road, RFD 5, Iowa City, Ia.

Fields: Nuclear physics, cosmic rays, atmospheric physics, use of rockets in physical research. Space physics, planetary astronomy, Discoverer of the Van Allen radiation belts in space.

WARREN, EARL

Born in Los Angeles, California, March 19, 1891. Son of Methias H. and Chrystal (Hernlund) Warren. Married to Nina E. Meyers, October 14, 1925. They have six children: James C., Virginia (Mrs. John Charles Daly), Earl, Dorothy (Mrs. Harry Van Knight, Jr.), Nina Elizabeth (Mrs. Stuart Brien), Robert. Attended public schools of Bakersfield. Graduated from University of California, 1912 (B. L. degree), and from School of Jurisprudence, University of California, 1914 (J. D. degree). Honorary degrees: LL. D., University of California and other universities and colleges. Admitted to California Bar, 1914. Private law practice, San Francisco and Oakland, 1914–17.

Enlisted U.S. Army as private, 1917; discharged as First Lieutenant, 1918 (Captain, Reserve Corps, 1919–35). Clerk, Assembly Judiciary Committee, California Legislature, 1919. Deputy City Attorney, Oakland, 1919–20. Deputy District Attorney, Alameda County, 1920–25. District Attorney, Alameda County, 1925–39. Attorney General of California, 1939–43. Governor of California, 1943 to October 1953. Chief Justice of the United States from October 5, 1953–June 24, 1969. Research Associate, Bureau of Public Administration, University of California, 1932–40. President, National Association of Attorneys General, 1940–41. Alternate delegate, Republican National Convention, 1928.

Delegate, Republican National Convention, 1932. Chairman, Republican State Central Committee, 1934–36. Republican National Committeeman from California and member, National Executive Committee, 1936–38. Temporary chairman and keynote speaker, Republican National Convention, 1944. Republican nominee for Vice President of the United States 1948. Special Ambassador of United States to Coronation of Queen Elizabeth II, 1953. Member, Board of Trustees National Geographic Society, American Philosophical Society; American Academy Arts and Sciences; State Bar of California; Alameda County Bar Association; Sacramento County Bar Association; Selden Society.

Fraternal organizations: Sigma Phi; Phi Delta Phi; Masons (33°), Grand Master, California 1935–36. Clubs: Olympic, Bohemian (San Francisco); Athens Athletic Claremont Country Club (Oakland); Jonathan, Californa (Los Angels); Sutter, Del Paso Country Club (Sacramento). Decorations: British Coronation Medal; Swedish Grand Cross of the Royal Order of the North Star; Order of Commander of the French Legion of Honor; Italian Star of Solidarity; Netherlands Order of Orange Nassau; Luxembourg Crown of Oak.

WHIPPLE, FRED L(AWRENCE)

Astronomer; b. Red Oak, Ia., Nov. 5, 1906; s. Harry Lawrence and Celestia (McFarland); student Occidental Coll., 1923–24; A.B., U. of Calif. at Los Angeles, 1927, Ph. D., U. of Calif. at Berkeley, 1931; A.M. (hon.), Harvard, 1945; D.Sc. (hon.), American International Coll., 1958; Temple Univ., 1961; D.Litt. (hon.) Northeastern Univ., 1961; LL.D. (hon.), C. W. Post Coll., Long Island Univ., 1962; m. Dorothy Woods, 1928 (div. 1935); 1 son, Earle Raymond; m. 2d., Babette F. Samelson, Aug. 20, 1946; children—Dorothy Sandra, Laura. Teaching fellow U. of Calif. at Berkeley, 1927–29; Lick Observatory fellow, 1930–31; instr. Standford summer 1929; U. of Calif. summer 1931; staff mem. Harvard Coll. Obs. since 1931, instr. Harvard, 1932–38, lectr., 1938–45, assoc. prof. astronomy, 1945–50, prof. astronomy since 1950, chmn. dept. astron., 1949–56; Phillips, Prof. 1968 director Smithsonian Astrophysical Observatory, 1955—. Research assoc. Radio Research Lab., O.S.R.D., 1942–45. Mem. Rocket and Satellite Panel, U.S., since 1946; mem. U.S. Nat. Adv. Com. on Aeronautics subcom., 1946–52; mem. U.S. Research and Development Bd. panel, 1947–52; mem. U.S. National Com. of the IGY (chmn. Tech. Panel on Rocketry, 1955–59, mem. Tech. Panel on Earth Satellite Program, 1955–59, mem. Working Group on Satellite Tracking and Computation, 1955–58); Div. Cttee. Math. and Physics, 1964–1968, mem. Adv. Panel on Astronomy to the Nat. Sci. Found., 1952–55, chmn. 1954–55; mem. of Com. on Meteorolgy of Nat. Acad. of Scis., Nat. Research Council, 1958—; delegate to Inter-American Astrophysical Congress, Mexico, 1942. Mem. of Commn. 22, Meteors, Zodiacal Light and Analogous Problems, of International Astronomical Union, 1946—; pres. of Commn. 22, 1946–52; pres. of Subcommn. on Meteorites, 1955–1961, mem. of Commn. 15, Physical Study of the Comets, 1952—; mem. of Commn. 34, Interstellar Material and Galactic Nebulae, 1950–55; mem. of Commn. 36, Spectrophotometry, 1935–52; Mem. Geophysics Panel, Space Tech. Panel Sci. Adv. Bd., U.S. Air Force 1953–62; Assoc. Advisor, 1963—: and mem. of Commn. 44. Astronomical Observations from Outside the Terrestrial Atmosphere, 1959—: voting repres. of U.S.A. in International Astronomical Union, 1952 and 1955; pres., Commn. 15, 1964—; vice pres. 1961–64; mem. Commn. 6, 1955–64, vice pres. 1961–64, acting pres. 1966—; mem., working gp. geodetic satellites, Cttee on Space Res. (COSPAR), 196—; working gp. on Tracking, Telemetary and Dynamics, 1960—; Ch. Sci. Council on the Geodetic Uses of Artificial Satellites, 1965—; mem., Internat. Astronautical Federation, 1955—; mem., Sci. Adv. Cttee, Internat. Acad. Astronautics, 1962—; corresponding mem., Royal Society of Scis., Liege, 1962—. mem. of Bio-Astronautics Com. of the Armed Forces and National Research Council, 1959–61; mem. of Com. on Standardization in the Field of Photography, Amer. Standards Assoc., 1938–50; mem. U.S. Nat. Com. of International Scientific Radio Union Commn. 3, 1949–1961; mem. of Upper Atmosphere Com. in the Meteorology Sec. of the Amer. Geophysical Union, 1957—; mem. of Com. on Cosmic and Terrestrial Relationships of the Amer. Geophysical Union, 1957—; Proj. Dir. Orbiting Astronomical Observatories, NASA, 1958—; NASA, Optical Ast. Panel, Ast. Missions Board, 1968—, NASA, Science and Technology Advisory Com., 1969— mem. of Aerospace Technology Panel for Space Physics, Int. of the Aerospace Scis., 1960—; Trustee-at-large, Univ. Corp. Atmospheric Res., 1964—; mem., Cttee on NCAR Staff-Univ. Relations, 1965—; Assoc. ed. of the Astrophysical Journal 1952–54, and Astronomical Journal, 1954–56, 1964—; ed. of Harvard Announcement Cards, 1952–60, Smithsonian-Contributions to Astrophysics, 1956—, and Planetary and Space Science, 1958—.

Active leader of project on Upper-Atmospheric Research via Meteor Photography 1946–57. Chief investigator of project, Optical Tracking of Artificial Earth Satellites in the IGY Program; project director, Harvard Radio Meteor Project, 1958—; Lowell, Lecturer, Lowell Institute, Boston, 1947; vice-pres., Amer. Astronomical Soc., 1948–50. Recipient: Donohue Medals for the independent discovery of six new comets; Presidential Certif. of Merit for scientific work during World War II; J. Lawrence Smith Medal of the Nat. Acad. of Scis. for research on meteors., 1949; Exceptional Service Award by U.S. Air Force for scientific service 1960; Medal from the University of Liege, Belgium for Astronomical Research, 1960. Space & Flight Award, Am. Astronautical Soc., 1961; Comdr., Order of Merit for Res. and Invention Esnault-Pelterie award by Ministry Education, Public Health and Ind., France, 1962; Distinguished Federal Civilian award from Pres. Kennedy, June, 1963. Space Pioneers Medallion, 1968 NASA Public Service Award for Contr. to OAO2 Development, May 1969. Mem. Phi Mu Epsilon, Phi Beta Kappa, Sigma Xi, Amer. Acad. of Arts and Scis., Amer. Philosophical Soc., Amer. Assoc. for the Advancement of Science, Nat'l Acad. of Science, 1959—, Amer. Meteoritical Soc., Amer. Geophysical Union, Amer. Meterological Soc., Fellow of the Amer. Astronomical Soc., Fellow of the Amer. Rocket Soc., Astronomical Soc. of the Pacific, Cosmos Club, and Examiner Club of Boston, Royal Soc. of Arts London, Benj. Franklin Fellow, 1968; Assoc. Editor, Astronomical J., 1954–56; 1964—; Editorial Bd., Space Sci. Review, 1961; Editorial Cttee., Annual Review of Astromical Astrophysics, 1965–69; Editorial Bd., Earth and Planetary Sci., Letters, 1966—; Contributor, Comments on Astrophysics & Space Physics, 1968; Author: Earth, Moon and Planets, Blakiston Company, 1942 2nd Rev. 1968; scientific papers on Comets, Asteroids and Meteors; Earth's Upper Atmosphere and Nature of Meteors by two-camera photographic method; Stellar and Solar-System Evolution; Theory of Comets; Optical Tracking of Artifical Earth Satellites; Astronomy from Space Stations; various subjects in the Encyclopaedia Britannica; various popular articles on astronomical subject. Invented Tanometer and Meteor Bumper. Office: Harvard College Observatory or Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, Mass. 02138 Home: 35 Elizabeth Rd., Belmont, Mass. 02178.

Fields: Photometry, computation of comet and planet orbits, comet discovery and theory, meteors, and the interplanetary medium, Earth's upper atmosphere, stellar and planetary evolution, Earth, Moon, and planets.

WIIO, OSMO ANTERO

Born February 4th 1928 in Porvoo, Finland, MA (Political Science) from University of Helsinki, Ph.D. (Communications Research) from University of Tampere 1968.

Professional journalist between 1948 and 1960. Science editor in the Finnish Broadcasting Corporation in 1960. Public Relations Manager for the Finnish Employers' Confederation 1961–69, Consultant to the SITRA Fund (sponsors industrial research and development) in 1969 and professor of organization theory and personnel management at the Helsinki School of Business Administration (University).

Author of 12 books on Technology, Mass Media and Communications Research Several hundred articles have appeared in various publications, several hundred radio and television programs, mostly on scientific subjects. One of the three commentators of the space programs for the Finnish Broadcasting Corporation since 1957.

Member of the Political Science Association of Finland, PR Society of Finland and the Radio Amateur Society of Finland (president 1960–66).

WILSON, JOHN T(ODD)

Psychologist; born: Mar. 7, 1914, Punxsutawney, Pennsylvania, A.B. (with distinction), The George Washington University, Washington, D.C., June 1941. Major, Psychology; minor, Philosophy. Emma K. Carr Scholar, 1939–41. Teaching Assistant, Experimental Psychology, 1939–41. Elected to Phi Beta Kappa, February 1941. M.A., The State University of Iowa, Iowa City, July 1942. Major, Psychology; minor, Education. Teaching Assistant, Elementary Psychology 1941–42. Elected to Sigma Xi, July 1942. Ph. D., Stanford University, Stanford, California, June 1948. Major, Psychology; minor, Educationa/Business Administration. Pre-doctoral Fellow, National Research Council (Rockefeller Foundation). Teaching Assistant, Experimental Psychology. Sci. D. (Hon), Washington & Jefferson College, Washington, Pennsylvania, June 1964. Research Assistant, Civil Aeronautics Administration projecton Selection of Pilot Trainees, College Park Airport, Maryland, September 1938–September 1939. Project Director, Dr. John P. Foley, Jr., George Washington University. Assistant Director of Personnel, Capital Transit Company, Washington, D.C., February 1941–September 1941. Again, July 1942–November 1942. Ensign, USNR, November 1942. Attached to Headquarters, Commander-in-Chief, U.S. Fleet, in connection with the development and administration of the selection and training program for radar operators and Combat Information Center Officers. Released as Lieutenant Commander, USNR, June 1946.

Assistant Executive Secretary, American Psychological Association, Washington, D.C. and Assistant Professor of Psychology, The George Washington University (concurrently), July 1948–June 1949. Head, Personnel and Training Research Branch, Office of Naval Research, Washington, D.C., June 1949–January 1952. Program Director for Psychology, Biological and Medical Sciences Division, National Science Foundation, January 1952–September 1955. Assistant Director for Biological and Medical Sciences National Science Foundation, September 1955–October 1961. Special Assistant to President, University of Chicago, Chicago, Illinois, October 1961–June 1963. Deputy Director, National Science Foundation, July 1963–September 1968. Vice President and Dean of Faculties, University of Chicago, October 1, 1968–1969. Provost, 1969–present. Member, Board of Regents, National Library of Medicine, 1957–61; Policy and Planning Board, American Psychological Association, 1956–59; Board of Trustees, Chicago Educational Television Association, September 1962–June 1963; Visiting Committee to the Departments of Psychology, Social Relations and the Psychological Laboratories, Harvard University, 1956–62; Board of Trustees, National Opinion Research Center, Chicago, Illinois, November 1962–June 1963; Illinois State Board of Higher Education, March 1963–June 1963; Various "Awards" Committees, such as: Phi Beta Kappa Science Award Committee; W. B. Saunders Science Writing Award Committee. Published numerous articles in his specific field. Also has written many book reviews and specialized chapters in textbooks.

ZUCROW, MAURICE J(OSEPH)

Jet propulsion expert and mech. engr.; born near Kiev, Russia, Dec. 5, 1899, son, Solomon and Dora (Smarskin); came to England, 1900, U.S., 1914, naturalized, 1921; B.S. in M.E. magna cum laude, Harvard, 1922, M.S., 1923; Ph. D., Purdue, 1928; married Lillian Feinstein, August 1, 1925; 1 dau., Barbara (Mrs. Louis A. Cohen). Consultant, 1966—; Emeritus Professor of Mechanical Engineering, Purdue University, 1966—; Atkins (Distinguished) Professor of Eng'g, 1959–65; Prof., gas turbines and jet propulsion, Purdue Univ., 1946–59; dir., Jet Propulsion Center, 1948–65; research assoc. and instr., Purdue, 1923; vice pres. in charge eng'g, Paragon Vaporizer Corp., Chicago, 1929–34; partner, Hubbard Eng'g Co., const., 1937–40; vice pres. and gen. mgr., Ring Balance Instrument Co., Chicago, 1940–41; research and development engr., Elliott Co., Jeannette, Pa., 1941–42; tech. asst. to exec. vice pres., Aerojet Eng'g Corp., Azusa, Calif., 1942–46; cons. engr. since 1946 Com. on Guided Missiles, Research and Development Bd., National Military Estab. (Chmn., Panel on Propulsion and Fuels, 1947–52, member, Technical Consulting Group, 1951–53, and consultant, Aeronautics Panel, Office of Asst. Secy. of Def. for R. & D., 1953–57); member, Ordnance Sci. Adv. Com., Dept. of Army, 1950–62; Nat Adv. Com. for Aeronautics (member, Subcom. on Propulsion Systems Analyses, 1947–50, chmn., Subcom. on Rocket Engines, 1950–53, and member, Subcom. on Rocket Engines, 1953–58); Nat. Aero. and Space Adm. (member, Adv. Com. on Chemical Energy System, 1960–62); member, Research Adv. Com. on Air Breathing Engines, 1962—; member, Science and Eng'g Com., Sec. of Automotive Engineers, 1959–62; member, Panel on Sci. and Tech., Com. on Science and Astronautics, House of Representatives, 1960—; and member, Bd. of Dir., Amer. Rocket Soc., 1951–55, 1957–61.

Member, Bd. of Dir., AIAA, 1962–65; member, Missile Adv. Group, AMICOM, Redstone Arsenal, 1962—; member, Weapons Adv. Group, Army Weapons Command, Rock Island Arsenal, 1965—; member, Div. Adv. Group WPAFB, USAF, 1962–63; Special Advisor, ASD, WPAFB, 1963—; consultant, Army Scientific Advisory Panel, 1965–67; Decoration for Distinguished Civilian Service, Dept. of the U.S. Army, 1967; Fellow, Amer. Soc. of Mech. Engineers; fellow (Amer. Rocket Soc.) (ARS Pendray Award in 1952); fellow, Amer. Inst. of Aero. and Astro (J. H. Wyld Propulsion Award, 1966); member, Internat. Acad. of Astronautics; member, Amer. Soc. of Eng'g Education (Vincent Bendix award, 1960); member, Amer. Sigma Xi (award, Purdue Univ., 1956), (Nat. Sigma Xi lectr., 1962), Tau Beta Pi, Pi Tau Sigma, Gamma Alpha Rho, Sigma Alpha Mu. Registered Professional Engineer, Indiana. Jewish. Author: Principles of Jet Propulsion and Gas Turbines, 1948, Aircraft and Missile Propulsion, vol. I and vol. II, 1958; co-author: Principles of Guided Missile Design, vol. II. Contributed over 60 articles to technical pubs., holder several patents. Home: 801 Arguello Street, Santa Barbara, Calif.

Fields: Jet propulsion, gas turbines, industrial instruments and control apparatus, rocketry, fuels.

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